May 1979
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Mariners Weather Log

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA

National Oceanic and Atmospheric Administration • Environmental Data and Information Service

U.S. DEPARTMENT OF COMMERCE
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Mariners Weather Log

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Cover: Gale warning pennants, flying briskly, signal bad weather for mariners approaching the Rhode Island coast at Watch Hill Light Station on January 5, 1979. Hugh breakers crash ashore at East Beach in Watch Hill. Wide World Photo.

ARTICLES

HINTS TO THE OBSERVER

TIPS TO THE RADIO OFFICER

HURRICANE ALLEY

ON THE EDITOR'S DESK

MARINE WEATHER REVIEW

MARINE WEATHER DIARY

Routing
Master ______________________
Observing Officers
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Radio Officer ______________________

PARTICIPATE IN AMVER

PLEASE PASS THIS ISSUE ALONG

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget through June 30, 1980.

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Mariners Weather Log

SHIP RESPONSE AND ENVIRONMENTAL SHIP ROUTING

William M. Clune
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Monterey, Calif.

The Fleet Numerical Weather Central (FLENUM-WEACEN) in Monterey, Calif., is embarking on an operational plan for Optimum Track Ship Routing (OTSR) using ship-response information in its environmental ship-routing program. Commencing in the spring of 1979, OTSR will be actively routing a U.S. Navy ship in the North Pacific. The ship will be instrumented to measure certain ship motions and stresses induced by ocean wave conditions. This is a joint project with the Maritime Administration and the U.S. Coast Guard and will last for at least 2 yr.

The project is in its earliest stages. Anticipated operational benefits will be essentially twofold. First, ship's officers should improve their ship handling in adverse sea conditions by being able to sense, analyze, and predict important ship motions through the use of on-board systems. Second, OTSR should improve route selection and surveillance procedures by using ship operational limits in conjunction with wave spectra and ship response as the primary routing factors, instead of ship's speed and wave height. With the use of such systems, officers will be able to adjust the recommended OTSR track for local conditions with some certainty as to the desired results.

SPECTRAL OCEAN WAVE MODEL

An important requirement in dealing with ship motions is to first provide an adequate description of the sea state. In late 1974, FLENUMWEACEN began providing spectral ocean wave data for the Navy's ship-routing services in both the Atlantic and Pacific. The Spectral Ocean Wave Model (SOWM) provides energy values from 12 different directions and 15 frequency bands with periods ranging from 3 to 26 s.

Figure 1 is an example of the SOWM matrix for two grid points computed at 1200 on January 20, 1979. It is based on the analyzed and forecast marine Planetary Boundary Layer (PBL) wind fields. The SOWM grid contains nearly 1,200 grid points in the North Pacific and 800 in the North Atlantic. Spectral wave forecasts are currently available every 12 hr out to 72 hr. A description of the meteorological and ocean

B

12Z 20 JAN 79 44.057N 165.164E

WIND DIR 283.6 WIND SPD 32.9 WHITE CPS 12 USTR 1.40 TAU 0

A

FREQ .308	.208	.158	.133	.117	.103	.092	.081	.072	.067	.061	.056	.050	.044	.039		DIR(FROM)
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	105.41
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75.41
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	45.41
0.000	0.000	0.000	0.000	0.000	.010	.030	.130	.030	.030	.030	.010	0.000	0.000	0.000	.270	15.41
.040	.110	.360	.420	.790	.950	1.480	2.140	.930	.880	.300	.050	0.000	0.000	0.000	8.450	345.41
.070	.180	.390	.450	.850	.980	1.600	2.470	1.090	.870	.380	.070	0.000	0.000	0.000	9.400	315.41
.080	.220	.400	.440	.800	.860	1.030	1.560	.530	.400	.300	.080	0.000	0.000	0.000	6.700	285.41
.070	.200	.310	.330	.570	.550	.540	.880	.430	.370	.180	.050	0.000	0.000	0.000	4.480	255.41
.040	.130	.170	.140	1.230	1.360	2.320	3.030	1.020	.670	.320	.100	.010	0.000	0.000	10.540	225.41
0.000	0.000	0.000	0.000	0.000	.020	.080	.020	.040	.230	.100	.010	0.000	0.000	0.000	.500	195.41
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.010	0.000	0.000	0.000	0.000	0.000	.010	165.41
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.010	.010	0.000	0.000	0.000	0.000	.020	135.41
C .300	.840	1.630	1.780	4.240	4.730	7.080	10.230	4.070	3.470	1.620	.370	.010	0.000	0.000 D	40.370	

E H1/3 25.41FT

SBPRO/GRDPT 2 69

12Z 20 JAN 79 41.485N 165.634E

WIND DIR 277.7 WIND SPD 31.2 WHITE CPS 12 USTR 1.31 TAU 0

FREQ .308	.208	.158	.133	.117	.103	.092	.081	.072	.067	.061	.056	.050	.044	.039		DIR(FROM)
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	106.74
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76.74
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	46.74
0.000	0.000	0.000	0.000	0.000	0.000	0.000	.030	.010	.010	.040	0.000	0.000	0.000	0.000	.090	16.74
.030	.090	.330	.380	.750	.890	1.300	1.610	.860	.790	.300	.050	0.000	0.000	0.000	7.380	346.74
.060	.160	.380	.430	.820	.940	1.550	2.430	.860	.620	.470	.100	0.000	0.000	0.000	8.820	316.74
.080	.220	.380	.420	.740	.840	1.320	1.900	.310	.220	.420	.150	0.000	0.000	0.000	7.000	286.74
.070	.220	.370	.420	.730	.770	1.160	1.560	.830	.640	.510	.130	0.000	0.000	0.000	7.410	256.74
.050	.180	.450	.490	.970	1.160	1.680	2.410	.850	.330	.210	.050	0.000	0.000	0.000	8.830	226.74
0.000	0.000	0.000	0.000	0.000	.020	.090	.280	.100	.110	.090	0.000	0.000	0.000	0.000	.690	196.74
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	166.74
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	.010	.010	.010	0.000	0.000	0.000	0.000	.030	136.74
.290	.870	1.910	2.140	4.010	4.620	7.100	10.220	3.830	2.730	2.050	.480	0.000	0.000	0.000	40.250	

H1/3 25.38FT

SBPRO/GRDPT 2 91

Figure 1. --Spectral Ocean Wave Model (SOWM) grid-point matrix for 1200 January 20, 1979.

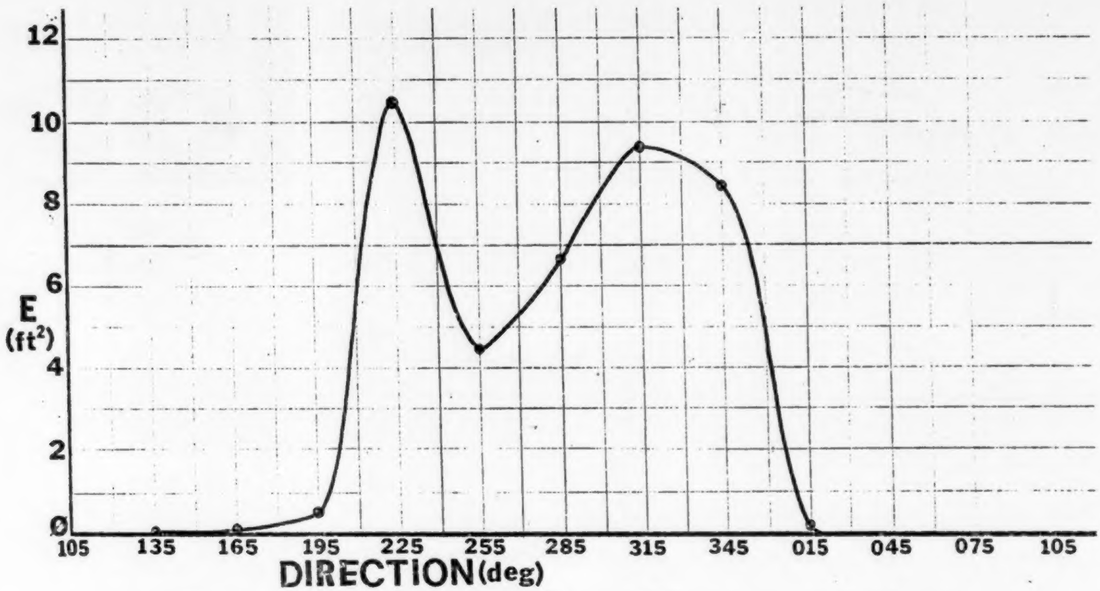

Figure 2.--Directional distribution of spectral wave energy given in figure 1.

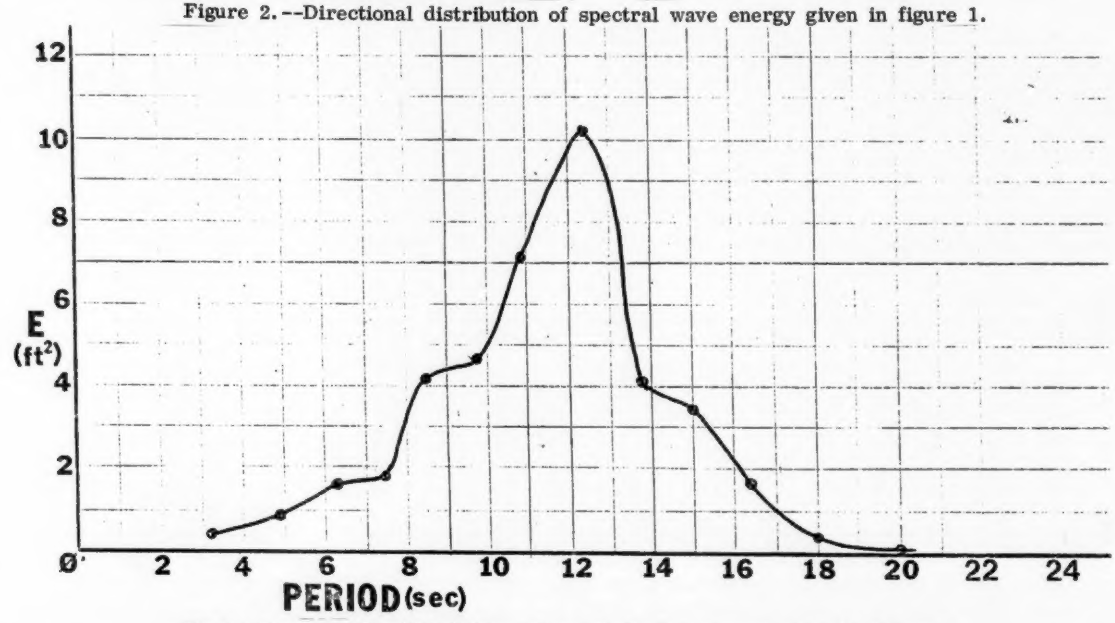

Figure 3.--Periodic distribution of spectral wave energy given in figure 1.

wave products and the OTSR service at FLENUMWEACEN can be found in the January 1975 issue of the Mariners Weather Log.

The analyzed and predicted SOWM data along the ship's intended track will be provided to the ship on a real-time basis for input in the on-board ship-response system for ship handling in local conditions, while OTSR will be using the SOWM data for a much larger ocean area for route selection and evaluation. In the initial phases of the project, SOWM data transmitted to the ship will include significant wave height ($H_{1/3}$) and primary and secondary wave directions and periods. As communication procedures improve, more extensive data may be provided if deemed valuable. For OTSR purposes, the primary and secondary wave systems are derived from the spectral wave program, where the primary wave has the principal energy (direction and period), and the secondary wave system must be equal to at least 20 percent of the primary wave energy.

Figure 2 illustrates the directional characteristics of the spectral wave energy using the information in

Box A of figure 1. This SOWM matrix example is bidirectional with the primary wave direction from 225° and the secondary wave direction from 315°. Box B of figure 1 shows the frequency range of wave energy of the SOWM matrix. It extends from .308 to .039 Hz (cycles) or 3.2 to 25.6 s (period = 1/frequency). Figure 3 is a plot of the frequency distribution of wave energy found in Box C. Peak wave energy is concentrated at .081 Hz or 12.4 s for both the primary and secondary wave directions. The total wave energy, E, of this matrix can be found in Box D of figure 1, where E equals 40.370 ft^2. Converting this to significant wave height, $H_{1/3} = 4\sqrt{E}$ or 25.41 ft, Box E.

An ideal type of wave condition that illustrates the SOWM ability to depict primary and secondary wave characteristics is when at least two maxima of wave energy values for both direction and frequency are present. This occurs when a wind-wave system (sea) overlays a longer period wave system (swell) with a sufficient difference in both direction and frequency to be considered bimodal. This type of wave system is a common occurrence especially during winter, when large storm areas generate wave systems with considerable energy and travel great distances into other wind-wave regimes.

SEAWORTHINESS, SEAKINDLINESS, SEAKEEPING, AND SHIP-MOTION GUIDANCE

Equally important to providing the spectral ocean wave energy data to the ship is supplying the routing agency with the response information for that particular vessel's characteristics based on a ship-motion analysis.

Ship design is primarily controlled by the necessary requirements to perform with maximum speed and seaworthiness over a wide range of conditions. Seaworthiness is an all-inclusive term indicative of the ship's capability to survive all sea hazards, such as collision, grounding, fire, and high winds and seas. Seakindliness refers to those qualities of ship operation that deal with the effects of the ocean environment. Some of the elements of seakindliness include speed performance, fuel consumption, reduction of damage to ship and cargo, and crew habitability and safety.

While seaworthiness and seakindliness deal with safe and efficient operation of a vessel, seakeeping describes the various ship motions and the associated dynamic effects. Some of the dynamic effects associated with ship motion are:

1. Shipping of water on the deck of a ship in heavy seas.

2. Slamming or sudden impact of the bottom of the ship on the water surface.

3. Vertical and lateral accelerations.

4. Speed loss in a seaway.

5. Propeller emergence or racing.

As these are all undesirable features of ship operability, seakeeping characteristics are closely associated with the degree of severity of the ocean environment. Dynamic effects cannot be determined solely by ship

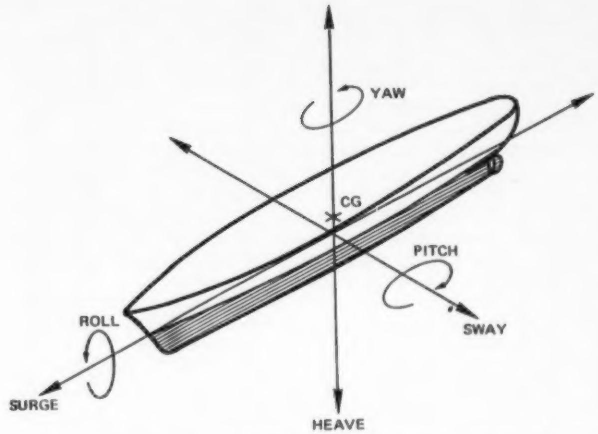

Figure 4.--Coordinate axes for ship motions intersect in waterline plane beneath CG.

motions, since they depend upon the relative position of the ship with respect to the spectral wave conditions.

If a body is free to move in a fluid, it will have six degrees of movement. Ship motion is separated into six component movements along the longitudinal, transverse, and vertical axes (linear motions) and the rotations about these axes (angular motions) (fig. 4). Individually, these movements are:

1. Surge--motion forward and backward in the direction of ship travel along the longitudinal axis.

2. Sway--athwartship motion of the ship along the transverse axis.

3. Heave--motion up and down in the vertical axis.

4. Roll--angular motion about the longitudinal axis. When the ship rolls, it lists alternately from starboard to port and back again.

5. Pitch--angular motion about the transverse axis. When the ship pitches, it trims alternately by the bow and stern.

6. Yaw--angular motion about the vertical axis. When the ship yaws, the bow and stern swing from side to side.

A ship experiences all six motions at the same time, and one type of motion is not independent of the others. Heaving, rolling, and pitching are oscillatory motions produced by the restoring forces when the vessel is disturbed from its equilibrium state. Similarily, surging, swaying, and yawing are nonoscillatory motions, and the vessel does not return to its original equilibrium when disturbed unless the exciting forces act alternately in opposite directions.

The adverse effects of ship motions may be divided into two categories: those related to the amplitudes of motion that directly affect the ship, such as shipping of water, slamming, and sea state; and those produced by severe motions which result in shifting of cargo and

equipment and crew discomfort or habitability.

Severe ship motions from adverse sea conditions usually result in the master voluntarily reducing power and probably changing course in order to provide a more comfortable ride. If the master has sufficient experience with the ship's particular hull type, he will attempt various heading and speed adjustments with some knowledge as to how these will affect ship motion. What the master lacks in determining a truly optimum track are the combined effects of the spectral wave and ship-response data with which to quantitatively evaluate the effects of the various course and speed changes before making an actual change.

In the current method of operations, the ship-routing meteorologist attempts to provide an optimum route by diverting around the forecast higher seas. In most situations, this results in increased distance to destination but with the rationale that ship speed is not going to be reduced on this new track. Even though the ship-routing agency had extensive meteorological and sea-state forecasts at hand, there was no way to properly evaluate the effect of the new track on ship motion. There are documented specific instances where a decision to provide lower seas was successful, but the ship motions on the new track were more adverse than if the ship's original track had not been changed. Thus, it would appear that providing the routing service and the master with real-time ship-motion data is the first step in developing a true environmental ship-routing service.

Using the calculations for the vessel's hull and loading characteristics for seakeeping, it is possible then to characterize the motions of interest for a particular hull. While the term "heavy pitching and rolling" is frequently found in ships' logs to qualitatively describe the adverse effects of the sea state on the ship, it is much more meaningful to use velocities, accelerations, or stresses as measured at specific points on the hull for operational guidance while in a seaway.

PLAN FOR TEST VESSEL

The vessel selected for the ship-response environmental ship-routing evaluation has a VC2-S-AP3 hull, an overall length of 455 ft, 11,000-ton displacement fully loaded, and a speed of 18 kn. The hull was built in World War II and extensively modified in 1964. Primary considerations in choosing this ship were the number of scheduled transits that will be available for evaluation over the next several years and potential for exposure to various wave conditions in that time period. Ports of call are at relatively high and low latitudes, so that all types of weather systems, from severe mid-latitude storms to tropical cyclones, will be part of the probable forecasting problems which will be encountered by OTSR.

Extensive experience with ships instrumented with motion sensors and related computer systems, though not weather routed, has shown the desirability of measuring certain ship responses and providing this information on a real-time basis to the master. The ship responses usually measured and recorded have been:

1. Midship bending stress, sagging and hogging;
2. Vertical acceleration;
3. Lateral acceleration;
4. Slamming; and
5. Bow impact.

For this project, ship's roll angle will be measured also. These are designated as the Response Amplitude Operators (RAO's) of the vessel.

To measure midship bending stress, strain gages will be installed on both port and starboard just forward of the midship line. Monitoring of midship strain not only provides the master with average bending stress, but also provides maximum and minimum stress due to wave motion and significant amplitude of this stress. Bending moments are a function of the motions and weight distribution and are used to measure hull stresses. Also, normally expected hull stresses and static stresses due to loading may exceed desired limits because of high vertical and lateral movements caused by adverse sea conditions.

Vertical and lateral acceleration will be measured by accelerometers installed forward near the bow under the fo'c'sle deck and on the ship's centerline. Accelerometers are very sensitive to small changes in course and speed and can identify specific damage-causing effects. Lateral acceleration is a function of roll, sway, and yaw and can lead to shifting of cargo and equipment when excessive. Vertical velocity and acceleration at the bow are primarily functions of pitch and heave. The dynamic effects range from wet decks in moderate seas to excessive plunging and slamming in higher sea conditions and are a major cause of hull damage. Shipping of water is a function of the relative velocity between the bow, ship's freeboard, and the wave system. Accelerations are a major concern to crew safety and influence the ability of the crew to perform effectively. Again, accelerations are directly related to cargo damage.

In addition to bending stress, the port and starboard midship strain gages can also be used to indicate the severity and frequency of slamming. Bow slam occurs when vertical accelerations induced by adverse wave action cause the forward portion of the ship to come out of the water and re-enter. This is a function of the relative motion of the bow as well as the velocity of re-entry. In this situation the forward bottom bow plates may sustain damage upon reentry. Slam impact is transmitted through the hull girders and can be filtered to record those slams above a certain intensity or frequency level.

Two of the main causes of shipboard damage are bow impact and shipping of water. Bow impact gages will be installed at the bow to measure impact stress induced in the structure due to wave action at this location. Quantitatively, bow impact is not as severe as slamming, but it is an indication of an adverse bow acceleration with the possibility of taking water over the bow. A warning system for shipping of water can be obtained by placing several strain gages on the side framing just below the fo'c'sle deck. These would indicate the magnitude of water impulses, their frequency of occurrence, and the probability of shipping of water on deck. Deck wetness causes damage to topside machinery and reduces the ability of the crew to do topside work.

Ship's roll angle will be measured with a vertical gyro installed near the ship's center of rotation. The significant and peak values of roll angle over a selected period of time will be measured and recorded. Due to the cost of the vertical gyro, ship's roll angle will be correlated with the lateral acceleration. This will ascertain the feasibility of using the lateral accelera-

tion as an indicator of ship's roll angle, thereby eliminating the cost of supplying a vertical gyro on other vessels.

Initial critical threshold values for the various responses have been established for the test vessel. These will be incorporated in an alert system to indicate to the master motions or stresses above certain predetermined levels. An alert indicator on the ship-response readout will show when:

1. The maximum amplitude of the midship bending stress, sagging and hogging, exceeds 15 kips (kilo lb/in^2).

2. Any acceleration, vertical or lateral, exceeds 0.3 g (significant) and 0.55 g (maximum) for a caution signal, and 0.4 g (significant) and 0.65 g (maximum) for a warning signal (g = gravity).

3. One bow slam exceeds 3.5 kips or two or more slams in 15 min exceed 2.5 kips.

4. One bow impact exceeds 3.5 kips or five transient impacts exceed 1.5 kips.

5. Significant roll angle exceeds 15° for a caution and 18° for a warning signal.

The constraints or threshold values selected for warning or alert levels can be modified operationally at any time to reflect changes in loading conditions, which may change the vessel's response to certain wave conditions, or to reflect the master's desires for the current voyage.

The constraint system will be an integral part of the Global Minimum Time Route (GMTR) computation process. the GMTR is the FLENUMWEACEN computer-selected optimum route based on a survey of the forecast ship motions between the departure point or ship's current position and the destination. The GMTR for the test vessel will be computed twice daily using environmental forecasts of wind and spectral wave conditions and applying the seakeeping calculations to determine the optimum ship track. The ship-response GMTR may indicate a track that minimizes or avoids adverse ship motions or one that takes advantage of optimum conditions and shortens the distance to destination.

SYSTEM DISPLAY

In addition to the computer console and sensors, other components of the system will include a cathode ray tube (CRT) terminal and chart recorder for display and storage of the ship-response and spectral wave data. These will be located so that they will be readily available to the bridge officer and other personnel. The CRT terminal will be used for making all input and output to the system, and any information displayed on the CRT can be saved by using the chart recorder. These will include the selection of operating modes, maneuvering analysis, and program changes.

The operating modes will include:

1. Continuous sampling mode--At sea the system and sensors will operate continuously and store information every 15 min. No event such as a slam, extreme acceleration, or roll above a certain threshold or frequency value will be missed, since it will be available through the computer terminal. Figure 5 is an outdated sample of the type of information available in the continuous sampling mode every 15 min. Maximum and minimum bending will indicate the highest sagging and hogging stresses, including the average and significant amplitude of the bending stress. Accelerations are shown as a mean value, or root mean square, and the highest vertical and lateral acceleration recorded. Transients are the number of bow slams and bow impacts and the highest intensity of each that occurred in the sampling period. For this project, maximum roll angle and significant amplitude of the roll will be part of the available data.

TIME	BENDING				ACCELERATION				TRANSIENTS					
				STD	VERT		LATERAL		SLAM		BOW		AFT	
	AVG	MAX	MIN	DEV	RMS	MAX	RMS	MAX	#	MAX	#	MAX	#	MAX
0017	1.4	7.5	- 8.3	2.2	.10	.32	.02	.10	2	2.8*	3	3.5*	0	.0
0032	1.5	7.8	- 9.1	2.0	.09	.37	.02	.10	1	2.4*	3	5.1*	1	.7*
0047	1.5	5.8	- 6.5	1.9	.09	.27	.02	.08	0	.0	0	.0	0	.0
0102	1.5	6.4	- 8.5	2.1	.09	.34	.02	.08	0	.0	5	3.0*	0	.0
0117	1.5	7.7	- 8.3	2.1	.09	.27	.02	.11	0	.0	6	4.6*	0	.0
0132	1.5	6.0	- 7.3	2.1	.10	.29	.02	.08	0	.0	4	3.1*	0	.0
0147	1.5	7.5	- 9.4	2.4	.11	.40	.02	.09	1	2.4*	6	3.5*	0	.0
0202	1.6	6.9	- 8.7	2.2	.10	.34	.02	.10	1	2.3*	6	4.2*	0	.0
0217	1.5	6.2	- 7.8	2.1	.10	.32	.02	.09	0	.0	5	3.0*	0	.0
0232	1.5	5.8	- 6.4	1.9	.09	.27	.02	.08	0	.0	1	2.5*	0	.0
0247	1.5	6.4	- 8.3	2.1	.09	.30	.02	.09	0	.0	1	3.1*	0	.0
0316	1.6	6.1	- 6.9	2.0	.09	.30	.01	.09	0	.0	1	2.9*	0	.0
0331	1.7	7.9	- 9.9	2.0	.09	.40	.02	.09	0	.0	8	5.6*	0	.0
0346	1.8	6.2	- 8.0	2.0	.09	.33	.01	.07	0	.0	2	2.6*	0	.0
0401	1.8	5.2	- 6.5	1.8	.08	.27	.02	.06	0	.0	3	2.9*	0	.0
0416	1.9	6.8	- 7.7	1.9	.09	.30	.02	.07	0	.0	4	4.0*	0	.0
0432	2.0	5.5	- 6.7	1.8	.08	.27	.02	.07	0	.0	0	.0	0	.0
0447	2.0	5.6	- 7.8	1.8	.09	.30	.02	.08	0	.0	3	3.3*	0	.0
0502	2.0	7.4	- 9.2	2.0	.09	.34	.01	.09	0	.0	3	3.1*	0	.0
0517	2.0	5.5	- 7.2	1.8	.08	.25	.02	.08	0	.0	2	4.7*	0	.0
0532	2.0	5.9	- 7.3	2.0	.09	.28	.01	.08	0	.0	4	3.4*	0	.0
0547	2.0	5.6	- 6.4	1.6	.08	.26	.02	.08	0	.0	1	2.4*	0	.0
0616	2.0	5.8	- 7.7	1.9	.09	.31	.01	.07	0	.0	2	3.1*	0	.0
0631	2.0	5.7	- 7.4	1.7	.08	.28	.01	.07	0	.0	2	4.0*	0	.0
0646	2.0	4.6	- 5.6	1.5	.07	.24	.01	.06	0	.0	1	3.6*	0	.0
0701	2.0	5.1	- 6.5	1.6	.08	.26	.02	.08	0	.0	0	.0	0	.0
0716	2.1	5.7	- 7.0	1.6	.08	.28	.01	.07	0	.0	1	4.1*	0	.0
0732	2.1	5.9	- 7.4	1.7	.08	.32	.01	.07	0	.0	1	2.7*	0	.0
0747	2.1	4.9	- 5.5	1.5	.07	.25	.02	.08	0	.0	1	2.9*	0	.0
0802	2.0	5.1	- 6.2	1.5	.08	.27	.02	.07	0	.0	1	2.8*	0	.0
0817	2.0	4.2	- 5.2	1.5	.07	.24	.02	.07	0	.0	0	.0	0	.0
0832	1.9	5.3	- 6.4	1.5	.08	.34	.02	.08	0	.0	1	2.6*	0	.0
0847	1.9	5.2	- 6.5	1.6	.09	.26	.02	.08	0	.0	2	3.4*	0	.0
0916	2.0	5.0	- 5.6	1.5	.07	.26	.02	.08	0	.0	1	4.1*	0	.0
0931	2.0	3.1	- 4.3	1.3	.06	.22	.02	.09	0	.0	0	.0	0	.0
0946	2.0	5.2	- 5.9	1.5	.08	.27	.02	.10	0	.0	1	2.7*	0	.0
1001	2.0	4.9	- 6.4	1.6	.08	.30	.01	.07	0	.0	2	2.7*	0	.0
1016	1.9	4.6	- 5.1	1.4	.07	.22	.01	.07	0	.0	0	.0	0	.0
1032	1.8	5.8	- 6.3	1.6	.08	.34	.02	.08	0	.0	3	3.0*	0	.0
1047	1.8	4.8	- 5.7	1.4	.07	.24	.01	.08	0	.0	0	.0	0	.0
1102	1.8	4.9	- 6.6	1.5	.08	.30	.02	.09	0	.0	2	2.9*	0	.0
1117	1.6	4.5	- 5.5	1.3	.07	.22	.02	.08	0	.0	0	.0	0	.0
1132	1.6	3.8	- 6.0	1.3	.07	.23	.02	.09	0	.0	1	3.3*	0	.0
1147	1.6	3.9	- 4.7	1.3	.07	.20	.02	.09	0	.0	0	.0	0	.0

Figure 5.--Continuous sampling mode printout.

2. Trend mode--The ability to establish trends by analyzing the recorded ship-response data over the previous 24-hr period. If no other means of analysis of data were available, the trend mode could be used to predict ship responses over a short-term period (several hours). Figure 6 is an example of the trend mode for midship bending during a 24-hr period (y-axis). The x-axis represents the percentage of the maximum value, or predetermined threshold value, which occurred within the period.

3. Prediction mode--The forecast wind and spectral ocean wave data or the ship's track could be entered and analyzed in conjunction with the vessel's response information stored in the on-board system. The result would be a forecast of the ship's responses for the time period of the available environmental forecast along the present ship's track, usually 60 to 72 hr.

4. Maneuvering analysis--The shipboard computer will be able to evaluate various course and speed

```
SELECT MODE

D =DATE/TIME/LOAD/CLEAR TRENDS
P =PREDICTION
M =MANEUVER ANALYSIS
T =TREND DATA

• T
TREND DATA
CHANNEL NO=1
```

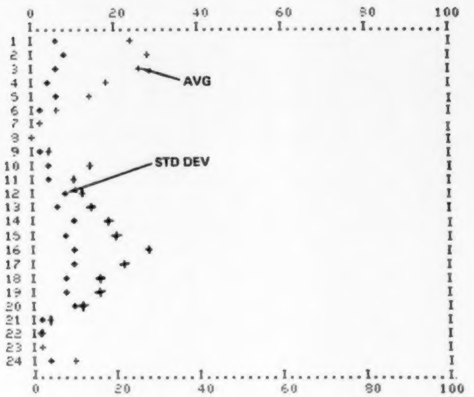

Figure 6.--Trend mode printout.

```
TIME        BENDING                   ACCELERATION                    TRANSIENTS
                              STD       VERT       LATERAL       SLAM        BOW       AFT
       AVG     MAX   MIN      DEV   RMS   MAX    RMS   MAX     #   MAX    #   MAX   #   MAX
0831   13.0    4.5 - 5.1   1.3• .10   .31   .11   .35    0   .0   4   6.4• 0   .0
0846   13.0    4.6 - 5.3   1.3• .10   .40   .15   .46    0   .0   5   3.8• 0   .0
0916   12.5    3.8 - 5.6   1.2• .11   .35   .11   .37    0   .0   5   4.2• 0   .0

0931   12.5    4.2 - 4.1   1.1• .11   .35   .12   .50    0   .0   4   1.6• 0   .0
0946   12.5    4.1 - 5.2   1.2• .12   .46   .10   .34    0   .0   5   1.7• 0   .0
1001   12.5    4.1 - 4.9   1.2• .11   .36   .11   .34    0   .0   5   3.8• 0   .0
1016   12.5    3.7 - 5.6   1.2• .11   .36   .12   .38    0   .0   2   3.3• 0   .0
1031   12.5    4.7 - 4.6   1.2• .10   .34   .12   .48    0   .0   5   2.6• 0   .0
1046   12.5    3.6 - 4.4   1.2• .11   .39   .11   .36    0   .0   5   1.6• 0   .0
M= MANEUVER ANALYSIS
F =FUEL ANALYSIS

•M
PRES. PREDICTIONS
CHAN  VALUE   NAME
 1    - 5.8   WAVE BM
 2     17.9   TOTAL BM
 3    - .45   VERT ACC
 4    - .67   LAT ACC
 5        0   SLAM
 6        4   BOW
 7        0   AFT

WAVE HEIGHT, FT      DIR.?
 XX.      XXX.
25.180.

PRES  SHIP SPD.      HDG.?
 XX.      XXX.
16.281.

NEW   SHIP SPD.      HDG.?
 XX.      XXX.
16.345.

MANEUVER WILL CHANGE WAVE LOADS (MOTIONS) AS FOLLOWS
BENDING   :    48%
ROLL      :  - 48%
BOW ACCEL :  - 75%
SHP WATER :    50%

NEW   SHIP SPD.      HDG.?
 XX.      XXX.
16.305.

MANEUVER WILL CHANGE WAVE LOADS (MOTIONS) AS FOLLOWS
BENDING   :    19%
ROLL      :  - 10%
BOW ACCEL :  - 35%
SHP WATER :  - 50%

1145   12.9    3.4 - 4.4   1.4• .04   .17   .07   .23    0   .0   0   .0   0   .0
```

Figure 7.--Maneuvering analysis mode printout.

changes in order to improve ship response (fig. 7). In this situation, the master has the ability to selectively adjust the OTSR-recommended track for the local sea conditions and the associated ship responses.

A descriptive monitoring mode will also be available for display on the CRT. This type of display will translate into plain language the results of the data for the period selected. Items to be displayed in plain language may include sea state, fuel analysis, cargo cautions, stability outputs, and excessive stress. If needed, additional items can be included by changes in the program.

The above description of some of the output products is from an earlier generation system. The product format for this study will be modified somewhat and will include roll angle.

CONCLUSIONS

It has only been in the recent past with the development of reliable ocean wave models and the advent of ship-motion theories that the naval architect has been able to consider the total effect of sea and ship for design and application of seakeeping technology. Modern ship designs, especially those with nonstandard cargoes and sophisticated transport methods, require individual attention to each vessel's operational requirements and areas of vulnerability. If various types of vessels and platforms are to operate successfully for extended periods of time in potentially hostile environments, improved or new methods of seakeeping will aid in reducing the time and expense in such conditions.

The primary goal of any ship-routing agency is to provide a safe, economical transit for a vessel; and, therefore, the success of such a service is dependent upon the routing agency's ability to make effective route recommendations and advisories. In this regard, the combined ship-response ship-routing project has several advantages over the current ship-weather-routing system. These are:

1. The ship-response environmental ship-routing system permits a new route to be computed at any time,

2. Route selections can be quantitatively evaluated by both ship's officers and OTSR, and

3. Recommended routes can be modified by observed or measured data.

Finally, the application of seakeeping considerations to ship routing allows for a greater definition of total operating costs and areas of vessel vulnerability than previously available. Successful prediction of ship response will further reduce heavy-weather encounters, cargo and hull damage, transit time, fuel consumption, and potential hazards to the crew. Additional savings will be realized from more efficient personnel use, improved topside working conditions, fewer emergency repairs to equipment, optimum scheduling of dockside activities, and, ultimately, extended ship-operating life.

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IMPORTANT NOTICE

With the recent implementation of mailing the Ship's Weather Observations forms (NOAA Form 72-1) directly to the National Climatic Center, Asheville, N.C., the Port Meteorological Officer no longer sees the form or acknowledges its receipt. Receipt of the forms will be acknowledged in the Mariners Weather Log under the heading "U.S. Cooperative Ship Weather Reports." The dates will correspond to the same months as the Smooth Logs, and the list will follow the tables of gale and wave observations. The list will include the ships' names in alphabetical order and the number of observations received both by radio and mail.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US. THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

EASTERN NORTH PACIFIC TROPICAL CYCLONES, 1978

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Tropical cyclone activity over the eastern North Pacific began on May 30 and ended October 20. Spanning 144 days, the 1978 season was 8 days shorter than the 1977 season. Table 1 shows the monthly distribution of the cyclone activity, and tables 2 and 3 compare this activity with that of recent years. The 1966-78 period was chosen for comparison since it probably includes all tropical-cyclone activity in the area owing to the excellent satellite coverage during that period. Prior to 1966 some activity was undetected because of the sparsity of data. A summary of the important features of the 1978 season is given in table 4. Cyclone tracks are shown in figures 8, 9, and 10.

Although the 1978 tropical cyclone season was 8 days shorter than the 1977 season, there was a 24-percent increase in the number of cyclones. The number reaching tropical storm or hurricane intensity nearly doubled from 47 percent in 1977 to 86 percent in 1978. The number of hours during which hurricanes were in progress increased from 128 in 1977 to 840 in 1978. Tropical storm hours also increased from 343 in 1977 to 873 in 1978. The highest sustained windspeed in 1977 was 90 kn compared to 120 kn in 1978. Of the 12 hurricanes during 1978, 6 had sustained winds of 100 kn or greater.

The 1978 tropical cyclone season was exceptional in that hurricane Norman became the third such storm in as many years to bring extensive rains to southern and central California (fig. 11). In 1977 hurricane Doreen brought heavy rains to California, and in 1976 hurricane Kathleen became the first tropical cyclone to hit southern California since 1939.

Tropical-cyclone advisories were issued by the Eastern Pacific Hurricane Center (EPHC) four times daily at 0000, 0600, 1200, and 1800. During the 1978 season 394 advisories were issued for 21 tropical cyclones, compared to 193 advisories for 17 tropical cyclones in 1977. This is a 104-percent increase in the number of advisories with only a 24-percent increase in the number of cyclones.

Many ships passed close to tropical-cyclone activity during the season and, undoubtedly, experienced heavy weather and seas, but none reported casualties or damage.

Only three tropical cyclones moved onshore during the season, one with 45-kn winds and the other two with 30-kn winds. No damage reports were received, probably because the cyclones were of low intensity and dissipated rapidly as they moved inland. Although hurricane Norman dissipated off the southern California coast, rain from the cyclone spread northward and caused considerable damage to agriculture in California during the first week in September. California lost 95 percent of its raisin crop--the worst loss on record. Figs and almonds were hard hit also. The rainfall was

Table 1.--Monthly distribution of eastern North Pacific tropical cyclones, 1978*

	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Tropical depressions	0	1	0	1	1	0	0	3
Tropical storms	0	1	1	2	1	1	0	6
Hurricanes	1	2	3	4	1	1	0	12
Total	1	4	4	7	3	2	0	21

*Cyclones are ascribed to the month in which they began.

Table 2.--Frequency of eastern North Pacific tropical storms and hurricanes combined by months and years*

Year	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
1966	0	1	0	4	6	2	0	13
1967	0	3	4	4	3	3	0	17
1968	0	1	4	8	3	3	0	19
1969	0	0	3	2	4	1	0	10
1970	1	3	6	4	1	2	1	18
1971	1	1	7	4	2	2	1	18
1972	1	0	1	6	2	1	1	12
1973	0	3	4	1	3	1	0	12
1974	1	3	3	6	2	2	0	17
1975	0	2	4	5	3	1	1	16
1976	0	2	4	4	3	1	0	14
1977	1	1	1	1	3	1	0	8
1978	1	3	4	6	2	2	0	18
Total	6	23	45	55	37	22	4	192
Average	0.5	1.8	3.5	4.2	2.8	1.7	0.3	14.8

*Cyclones are ascribed to the month in which they began.

Table 3.--Number of eastern North Pacific tropical storms reaching hurricane intensity by months and years*

Year	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
1966	0	1	0	4	2	0	0	7
1967	0	1	0	2	1	2	0	6
1968	0	0	0	3	2	1	0	6
1969	0	0	1	1	1	1	0	4
1970	1	0	1	1	0	1	0	4
1971	1	1	5	2	2	1	0	12
1972	1	0	0	6	1	0	0	8
1973	0	1	3	0	2	1	0	7
1974	0	2	2	4	2	1	0	11
1975	0	1	2	3	1	1	0	8
1976	0	2	1	2	3	0	0	8
1977	0	0	1	1	1	1	0	4
1978	1	2	3	4	1	1	0	12
Total	4	11	19	33	19	11	0	97
Average	0.3	0.8	1.5	2.5	1.5	0.8	0.0	7.5

*Cyclones are ascribed to the month in which they began.

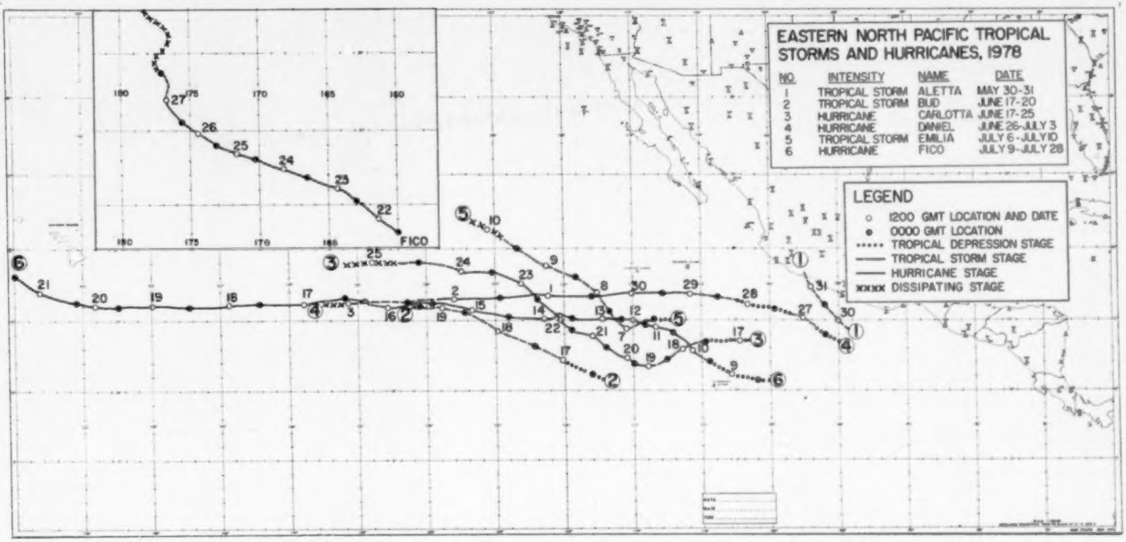

Figure 8.--Tracks of eastern North Pacific tropical cyclones, May 30 to July 28.

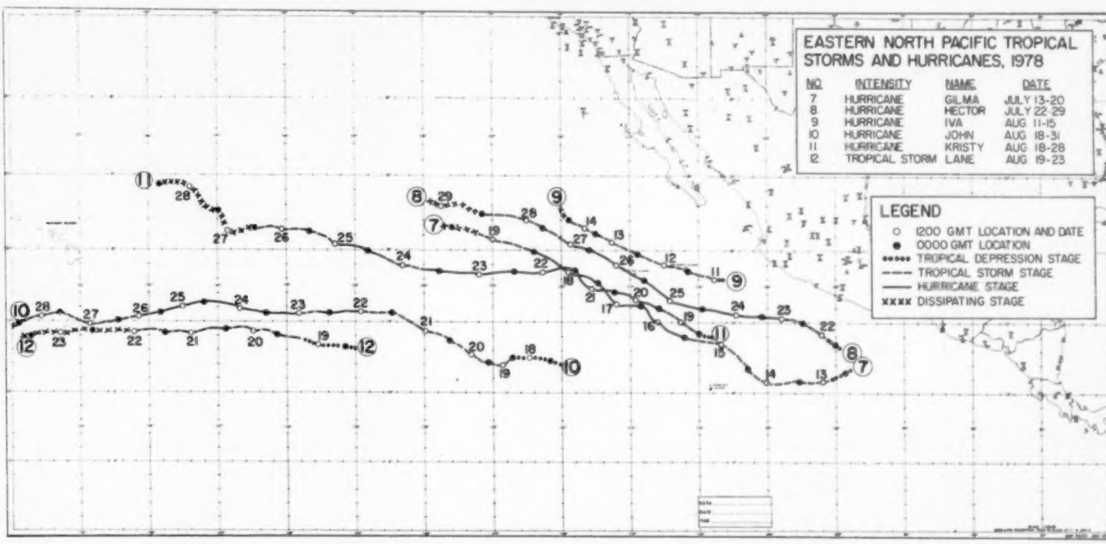

Figure 9.--Tracks of eastern North Pacific tropical cyclones, July 13 to August 23.

not especially heavy, but it was extensive; lingering cloud cover prevented crops from drying out, increasing the losses. Agricultural losses are estimated in excess of $300 million.

The National Environmental Satellite Service Field Station, collocated with the Eastern Pacific Hurricane Center, provided excellent satellite coverage during the 1978 tropical cyclone season. Several movie loops were available each day, as well as visual and infrared data at 30-min intervals from the stationary SMS-2 (Synchronous Meteorological Satellite) and NOAA polar-orbiting satellites. The detail on the satellite imagery was excellent with full-disk resolution at 4 mi, sector resolution at 2 mi, and 1/2-mi resolution available on request. Especially useful were H-curve "enhanced" pictures from infrared imagery depicting the upper level cold centers of the tropical cyclones. The gridding of satellite pictures was accurate to within a few miles owing to the stability of SMS-2 over the Equator and easily visible landmarks. Cyclonic intensity was calculated using the Dvorak technique of satellite cyclone analysis.

The U.S. Air Force made four reconnaissance flights into eastern North Pacific tropical cyclones during the season. The first flight, with two penetrations, was made into hurricane Norman on September

Table 4. --Eastern North Pacific tropical cyclones, 1978

(All times GMT, latitudes north, longitudes west. Hu = hurricane, Ts = tropical storm, Tc = tropical cyclone)

Cyclone/ Lifespan	Depression	Storm	Hurricane	Storm	Depression	Final Position	Highest Sustained Wind From	 To	 Kt
Hu Aletta 30-31 May		301200 15.0-100.0	310000 16.2-101.0	310600 16.8-101.6		311800 18.0-102.1	310000 16.2-101.0	310600 16.8-101.6	65
Ts Bud 17-20 June	170000 11.2-118.0	171200 12.2-120.2			200000 16.0-130.6	200600 16.2-131.5	180000 13.2-122.3	190000 15.5-127.2	50
Hu Carlotta 17-25 June	170600 13.7-106.1	180000 13.5-109.7	190600 11.9-113.3	240000 18.3-125.3	250600 19.2-132.2	251800 19.1-135.6	211200 13.9-118.1	221800 15.9-121.1	115
Hu Daniel 26 June-3 July	261800 13.6-100.1	270600 14.7-101.7 281500 16.5-107.2	 291800 16.9-111.9	 021800 16.8-129.7	271800 15.6-103.6 031200 17.3-135.8	 031800 16.4-137.8	 301200 16.8-115.2	 011800 16.7-123.0	 100
Tc Five 30 June-2 July	300600 14.0-125.5					020000 11.5-135.0	300600 14.0-125.5	020600 11.5-135.0	25
Ts Emilia 6-10 July	061800 15.0-112.5	070000 15.0-113.5			100600 20.7-124.5	101800 21.7-126.7	090600 18.4-120.2	091200 18.8-121.3	55
Hu Fico 9-17 July	090000 10.8-105.9	100000 12.1-109.5	101800 13.6-111.4			171200* 16.1-138.9	121200 15.0-115.0	130000 14.9-116.0	120
Hu Gilma 13-20 July	130000 11.4-099.5	130600 11.0-100.3	151800 14.8-109.8	190000 19.9-122.3	191800 21.0-126.8	200000 21.6-128.2	160600 14.9-112.2	161200 15.0-113.2	100
Hu Hector 22-29 July	220000 13.4-100.2	220600 13.7-100.7	231200 15.3-104.1	271800 20.9-120.3	290000 22.4-126.1	291800 23.5-130.0	250600 16.2-111.1	260000 18.0-114.0	120
Tc Ten 8 August	081200 14.4-130.6					081800 14.0-131.8	081200 14.4-130.6	081800 14.0-131.8	30
Hu Iva 11-15 August	110600 18.0-108.0	111200 18.0-109.0	130600 20.1-115.7	140000 21.1-117.7	150000 22.0-119.6	150600 22.5-120.0	130600 20.1-115.7	140000 21.1-117.7	65
Hu John 18-23 August	180000 12.2-121.0	190000 12.3-123.8	221200 15.7-134.8	230600 15.4-138.2		231200* 15.4-139.4	221200 15.7-134.8	221800 15.6-135.8	70
Hu Kristy 18-26 August	181800 13.6-109.2	190000 14.1-110.0	191800 15.5-112.3 250000 19.8-134.2	240600 18.7-130.3 251800 20.8-137.4		 260600* 21.3-139.1	 210600 17.3-117.2	 221800 18.5-122.5	 90
Ts Lane 19-20 August	190000 13.2-135.8	191800 13.7-139.0				200000* 14.4-139.8	200000 14.4-139.8	200000 14.4-139.8	45
Ts Miriam 23-27 August	231500 10.9-114.9 261800 12.8-133.5	 270000 13.2-134.8				260000 12.1-129.0 271800* 12.7-138.8	240000 10.8-116.0 270000 13.2-134.8	250600 11.2-123.0 271800 12.7-138.8	 30 35
Hu Norman 30 Aug.-6 Sep.	301800 12.8-098.0	310000 12.8-098.8	010600 14.6-103.0	041800 25.3-120.7	051800 30.7-119.1	060000 32.5-118.5	030000 19.8-112.4	030600 20.3-113.9	120
Tc Seventeen 8-9 September	080000 12.0-099.0					090000 14.3-099.5	080000 12.0-099.0	090000 14.3-099.5	25
Hu Olivia 20-23 September	200000 16.0-093.0	200600 15.0-094.0	220000 14.0-094.8	221800 15.9-094.3		230000 16.5-094.0	220000 14.0-094.8	221800 15.9-094.3	65
Ts Paul 23-26 September	230000 14.1-100.5	251200 20.3-109.5			261200 25.0-108.2	261200 25.0-108.2	251800 21.6-109.4	260600 23.9-108.8	40
Hu Rosa 2-7 October	021800 13.9-102.7	030000 14.9-103.7	040000 17.6-107.6	051800 21.3-109.9	061800 22.8-110.6	070000 22.9-111.1	041800 19.1-109.1	051200 20.7-110.0	75
Ts Sergio 18-20 October		181800 15.9-107.7			200600 21.7-113.9	201800 24.0-114.0	181800 15.9-107.7	200600 21.7-113.9	35

*Passed to Central Pacific Hurricane Center (CPHC)

2, when the cyclone was about 240 mi southwest of the tip of Baja California. The next day another flight was made into Norman when he was 370 mi west of the tip of Baja California. Two days later a third flight was made into Norman on September 5. The cyclone had moved into a position 155 mi southwest of San Diego and was weakening rapidly from tropical storm to depression stage. The final reconnaissance flight of the season was made into hurricane Rosa on October 5. This flight, with three penetrations into the cyclone, was made as Rosa weakened from hurricane to tropical storm stage while 110 mi south of the tip of Baja California.

While satellite imagery continues to improve and is probably one of the most important tools used by the tropical forecaster today, aircraft reconnaissance and synoptic ship reports are as important as ever as invaluable ground-truth observations for both the tropi-

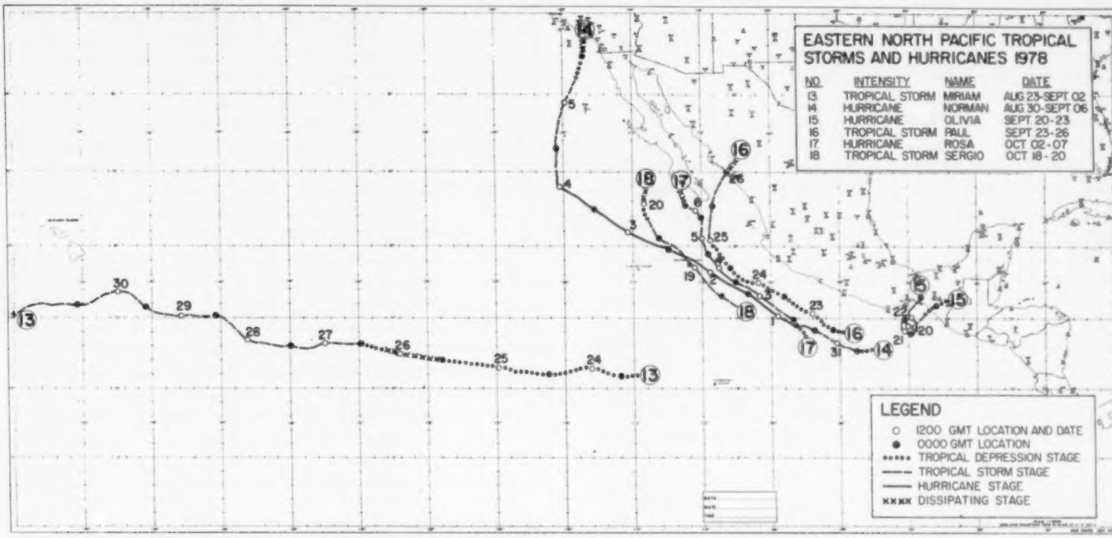

Figure 10.--Tracks of eastern North Pacific tropical cyclones, August 23 to October 20.

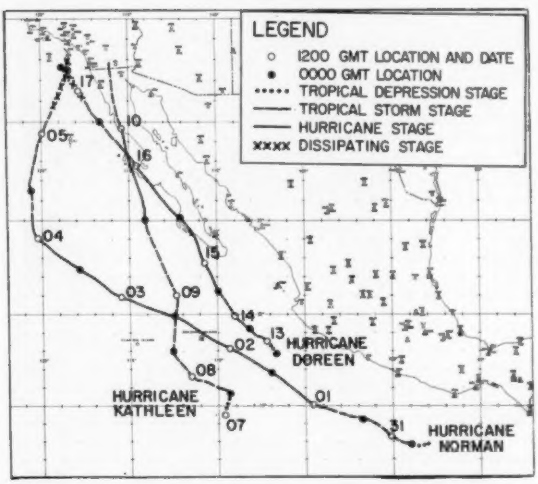

Figure 11.--A comparison of the tracks of the three hurricanes that affected southern California in the last 3 yr--Kathleen in September 1976, Doreen in August 1977, and Norman in September 1978.

cal forecaster and satellite meteorologist.

Several computer-derived forecasts of tropical cyclone tracks for the eastern North Pacific were available from the National Hurricane Center in Miami during the 1978 season. The forecast tracks included simulated analog (CLIPPER), statistical synoptic (EPHC77), analog (EPANALOG), and barotropic (SANBAR) models. The movable fine-mesh model (MFM) was available on request from the National Meteorological Center in Maryland. Table 5 shows the average forecast error computed by the Scientific Services

Table 5.--Forecast errors

(Number of cases/average error in n mi)

Forecast period	24 hr	48 hr	72 hr
EPHC Forecasters	266/83	184/156	140/217
EPANALOG	257/87	185/155	147/244
EPHC77	241/91	177/163	138/236
CLIPER	257/86	188/153	148/226
SANBAR	57/94	50/211	40/357

Division of the NWS Western Region for each of the models during the 1978 season. The average forecast error for EPHC is included.

The average forecast error for EPHC for 1978 for the 24-, 48-, and 72-hr forecast periods was 152 mi, an improvement of 42 percent over the 1977 average. The combined error for computer-derived forecasts was 176 mi, an improvement of 48 percent over 1977 computer-derived forecast errors. The slight improvement of the computer-derived forecasts over EPHC forecasts is partially due to the fact that computer errors in 1977 were so much larger than EPHC errors, leaving greater room for improvement. Computer-derived forecasts during 1978 were superior to those of 1977 also because of improved "best-tracking" methods for the past 12- and 24-hr positions. Considering only the 24-hr forecasts, the EPHC forecasts improved 52 percent over their 1977 errors, while the computer-derived forecasts improved 49 percent. At the 48-hr period both EPHC and computer forecasts showed equal improvement of 53 percent. At the 72-hr period the EPHC forecasts improved only 31 percent compared to 45 percent for the computer fore-

casts, a direct result of the large spread (102 mi) between 1977 errors.

Only named tropical cyclones (winds ≥34 kn) are described. There were three numbered cyclones that did not develop beyond the depression stage.

Four tropical storms and one hurricane moved into the central North Pacific forecast region from the eastern North Pacific forecast region. The description of these cyclones is continued in the accompanying article, "Central North Pacific Tropical Cyclones, 1978."

HURRICANE ALETTA - MAY 30-31

The 1978 tropical cyclone season began on May 27 with a small disturbance over the eastern Gulf of Tehuantepec. It expanded rapidly, moved southwestward at 20 kn, and reached 10°N, 100°W, by late evening of the 28th. It then turned northward and, with additional thunderstorm activity flowing into the area from the Inter-tropical Convergence Zone (ITCZ) to the south, began to intensify slowly. By 1200 on the 30th satellite imagery showed the center of the disturbance with a diameter of 300 mi, and it was upgraded to tropical storm Aletta near 15°N, 100°W, about 110 mi south of Acapulco, Mexico. The storm was moving northwestward at 8 kn and intensifying. By 1800 the center was near 15.6°N, 100.5°W, about 90 mi south-southwest of Acapulco. The FRESNO CITY reported 51-kn easterly winds 60 mi to the north, and another ship about 50 mi north-northeast of the storm had 65-kn southeasterly winds. By 2200 a small eye was visible on

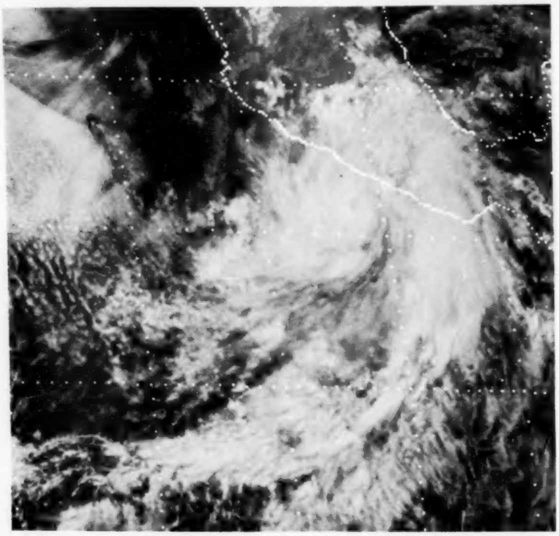

Figure 12.--An SMS-2 visible satellite picture of Aletta 100 mi southwest of Acapulco.

satellite pictures (fig. 12). Aletta continued to move northwestward and was upgraded to a hurricane with 65-kn winds near 16.2°N, 101°W, at 0000 on the 31st. Aletta was now 90 mi west-southwest of Acapulco and moving northwest at 8 kn over 81°F water. By 0600 winds near her center (16.8°N, 101.6°W) had decreased to 50 kn, and the hurricane was downgraded to a tropical storm. Moving between high pressure aloft over southern Mexico and a trough of lower pressure aloft over northwestern Mexico, Aletta turned to the north-northwest toward the Mexican coast. By 1200 Aletta was 30 mi west of Zihuatanejo. Winds near the center had decreased to 45 kn. Slowing to 5 kn, Aletta moved onshore 45 mi west-northwest of Zihuatanejo at 1730. Although the storm dissipated rapidly after moving inland, convective activity lingering near the coast continued 30- to 40-kn winds over the offshore waters through 1800 on June 1.

TROPICAL STORM BUD - JUNE 17-20

The second tropical cyclone of the 1978 season began as a tropical disturbance 700 mi west-southwest of Acapulco on June 15. It moved west-southwestward at 12 kn over 84°F water for 24 hr, then turned west-northwestward and began to intensify. By 0000 on the 17th, cyclonic circulation was evident; and the disturbance was upgraded to a tropical depression near 11.2°N, 118°W. The RIVERBANK helped locate the center of the cyclone during this period. By 1200 the winds had increased to 35 kn, and the depression was upgraded to tropical storm Bud near 12.2°N, 120.2°W.

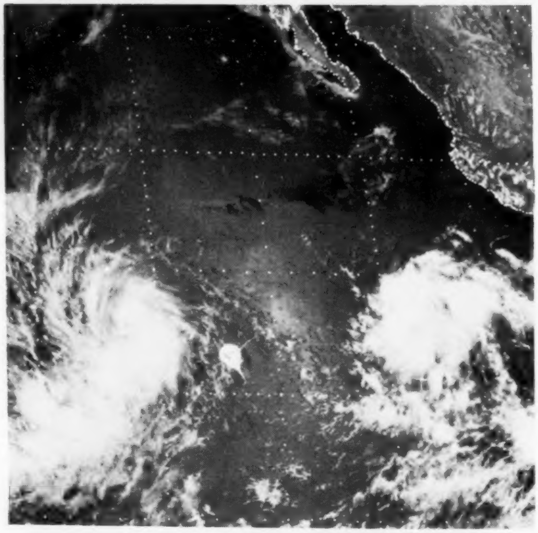

Figure 13.--Tropical storm Bud 900 mi southwest of the tip of Baja California. The third cyclone of the season is beginning to form 740 mi to the east.

By 1800 Bud had moved to 12.6°N, 121.3°W (fig. 13). The third cyclone of the season, later to become hurricane Carlotta, was beginning to develop 740 mi to the east. Ship reports relayed through the U.S. Coast Guard at Point Reyes indicated 40- to 50-kn winds 100 mi north of the storm's center and gusts as high as 60 kn within 30 mi of the center. Observations from the cargo ship ANDOMALES and the research ship DEEPSEA MINER II were of great value in locating Bud's center at this time. The DEEPSEA MINER II reported gusts to 50 kn about 40 mi from the center. With sustained winds of 50 kn and gusts to 65 kn, Bud continued to move west-northwestward to 15°N, 126°W, by 1800 on the 18th. Bud moved over 80°F water and began to

weaken; by 0600 on the 19th the center was near 15.9°N, 127.9°W, and the winds had decreased to 40 kn. Bud turned westward and, slowing to 8 kn, began to weaken rapidly. By 0000 on the 20th winds had decreased to 30 kn, and Bud was downgraded to a tropical depression near 16°N, 130.6°W. Drifting under a weak upper level high-pressure area, the cyclone continued to weaken. The final advisory was issued at 0600 on June 20 with the center near 16.2°N, 131.5°W.

HURRICANE CARLOTTA - JUNE 17-25

While Bud was still a disturbance on June 15, another disturbance began to develop 700 mi east of Bud and 300 mi south of Acapulco. Moving west-northwestward, the new disturbance began to intensify. By 0600 on the 17th cyclonic circulation was visible, and the disturbance was upgraded to a tropical depression near 13.7°N, 106.1°W, about 400 mi west-southwest of Acapulco. Convective activity extended over a diameter of 450 mi, small when compared to the 750-mi diameter associated with Bud, 770 mi to the west. Turning westward, the depression continued to intensify over 84°F water. The MAMMOTH FIR helped locate the center. By 0000 on the 18th, winds near the storm's center had increased to 35 kn, and the cyclone was upgraded to tropical storm Carlotta near 13.5°N, 109.7°W, about 200 mi north of Clipperton Island. The tropical storm then turned toward the west-southwest. Moving along almost the same track that Bud had taken, the storm moved around the southern side of an upper level high-pressure area centered over central Baja California. A small eye was visible on satellite pictures by 0000 on the 19th. Winds increased to 65 kn by 0600, and Carlotta was upgraded to a hurricane near 11.9°N, 113.3°W, about 260 mi west-northwest of Clipperton Island. Six hours later the cyclone reached its southernmost position at 11.8°N, 113.9°W, and continued to intensify over 83°F water. Carlotta reached maximum intensity of 115 kn at 1200 on June 21 (fig. 14) near 13.9°N, 118.1°W. Moving west-northwestward, Carlotta reached 14.3°N, 119.5°W, at 0000 on the 22d, then turned northwestward, and began to weaken over colder 78° to 81°F water during the next 12 hr. By 1200 on the 23d Carlotta was moving into a field of low clouds. Winds decreased to 60 kn by 0000 on the 24th, and Carlotta was downgraded to a tropical storm near 18.3°N, 125.3°W. Moving at 12 to 16 kn over 77°F water, she turned westward and weakened rapidly. By 0600 on the 25th winds had diminished to 25 kn, and the storm was downgraded to a tropical depression near 19.2°N, 132.2°W. The final advisory was issued at 1800 on June 25 with the center near 19.1°N, 135.6°W.

HURRICANE DANIEL - JUNE 26-JULY 3

Daniel began as a tropical disturbance 210 mi southwest of the Nicaraguan coast on June 24. He moved west-northwestward at 15 kn and intensified over 82°F water. Cyclonic circulation was visible about the center by 1800 on the 26th, and the disturbance was upgraded to a tropical depression near 13.6°N, 100.1°W, about 200 mi south of Acapulco. The cyclone then turned northwestward and with winds now 35 kn was upgraded to a tropical storm at 0600 on the 27th near 14.7°N, 101.7°W. Winds continued at 35 kn for the next 12 hr, then began to decrease as Daniel turned westward over 80°F water. The storm was downgraded to a tropical depression again at 1800 on the 27th near 15.6°N, 103.6°W. The DAMPIER MARU, sailing 40 mi west of the depression, was helpful in locating its center. Winds increased after 1200 on the 28th. By 1500 they had reached 55 kn, and Daniel was again a tropical storm near 16.5°N, 107.2°W. He continued westward, passing 110 mi south of Socorro Island and 380 mi south of the tip of Baja California at 1600 on the 29th (fig. 15). By 1800 winds had reached 65 kn.

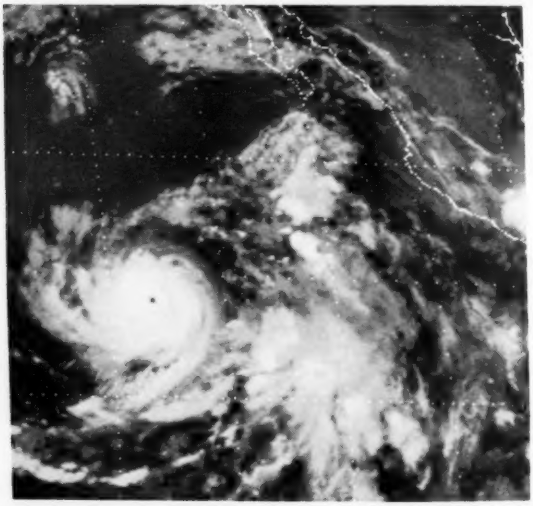

Figure 14. --Infrared image of Carlotta with 115-kn winds and a well-defined eye at 1215 on June 21.

Figure 15. --Polar-orbiting NOAA-5 image with 1/2-mi resolution shows Daniel 380 mi south of the tip of Baja California.

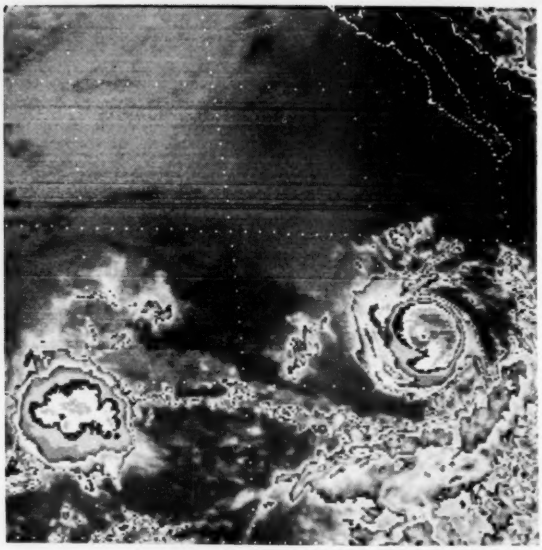

Figure 16.--Enhanced infrared image shows tropical cyclone five developing near 14°N, 125.5°W, on June 30. Daniel is 700 mi to the east.

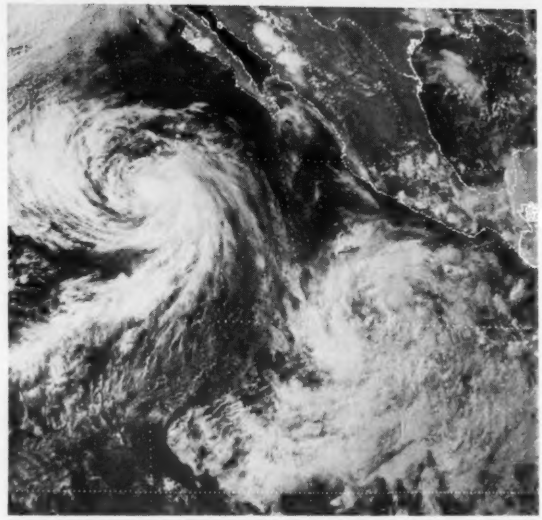

Figure 17.--Tropical storm Emilia is 600 mi west-southwest of the tip of Baja California late on July 8, and the seventh cyclone of the season is developing 880 mi to the southeast.

and Daniel was upgraded to a hurricane near 16.9°N, 111.9°W. Observations were received from the NORSE VIKING 140 mi to the southwest. Daniel accelerated toward the west and continued to intensify (fig. 16). At 1200 on the 30th his winds peaked at 100 kn near 16.8°N, 115.2°W, and remained at this intensity for 24 hr. The hurricane moved rapidly westward at 16 kn along the southern edge of the eastern Pacific High. By 1800 on July 2, Daniel's winds had decreased to 45 kn, and he was downgraded to a tropical storm near 16.8°N, 129.7°W. Daniel continued to move westward at about 20 kn. His winds diminished and he was downgraded to a tropical depression near 17.3°N, 135.8°W, at 1200 on the 3d. The cyclone then turned west-southwestward and began to dissipate rapidly over 75°F water. The final advisory was issued at 1800 on the 3d with the center near 16.4°N, 137.8°W.

TROPICAL STORM EMILIA - JULY 6-10

A tropical disturbance formed east of Acapulco on July 3 and moved southwestward off the coast of Mexico to near 15°N, 101.3°W, by 1800 on the 4th. It then turned westward, accelerated to 16 kn, and intensified over 85°F water. Satellite pictures showed cyclonic circulation about the center, and the disturbance was upgraded to a tropical depression at 1800 on the 6th near 15°N, 112.5°W, about 750 mi west of Acapulco. Winds reached 35 kn on the 7th and the depression was upgraded to tropical storm Emilia at 15°N, 113.5°W. By 1200 the storm had moved to 14.5°N, 115.4°W. It then turned northwestward and continued to intensify. Winds near the center reached 50 kn (fig. 17) on the 8th and maximum intensity of 55 kn by 0600 on the 9th. Hurricane Fico was developing 900 mi to the east-southeast near 10°N, 105.8°W. The MARCONA EXPORTER provided valuable observations as Emilia continued her northwestward movement. Emilia's winds decreased over cooler 79°F water, and by 0600 on the 10th she was only a depression near 20.7°N, 124.5°W. The final advisory was issued at 1800 on July 10 with the center near 21.7°N, 126.7°W.

HURRICANE FICO - JULY 9-28

Hurricane Fico began as a tropical disturbance 450 mi south-southeast of Acapulco on July 6. The disturbance moved westward at 10 kn and intensified over 81°F water. A cyclonic circulation was evident on satellite pictures by 0000 on the 9th, and the disturbance was upgraded to a tropical depression near 10.8°N, 105.9°W. The depression then turned toward tropical storm Emilia, 870 mi to the west-northwest. The MARCONA EXPORTER and UNION SUNRISE helped to locate the center. Fico attained tropical-storm intensity on the 10th near 12.1°N, 109.5°W, about 400 mi south of Socorro Island and 100 mi north of Clipperton Island. He then turned northwestward and intensified rapidly over 84°F water. By 1800 he was a hurricane with 65-kn winds near 13.6°N, 111.4°W. Fico now had a well-developed eye. He turned west-northwestward and continued to intensify. By 1200 on the 12th winds near his center had reached maximum intensity of 120 kn near 15°N, 115°W, 325 mi southwest of Socorro Island. The CHEVRON GENOA and PRIPIATLES were helpful in locating Fico. With high-level outflow extending 250 mi from the center, Fico turned westward to 15.1°N, 118.4°W, by 1800 on the 13th. The hurricane had passed over a pocket of cool 79°F water, and winds decreased rapidly to 80 kn by 0600 on the 14th. Continuing westward, Fico once again moved over warm 83°F water. By 1200 his winds had increased to 105 kn, and by 0000 on the 15th he had 115-kn winds near 15.3°N, 124°W. Figure 18, a visible satellite picture with 1/2-mi resolution, shows Fico at 0115 on the 17th with 115-kn winds near 16.5°N, 136.1°W. The EPHC issued its final advisory on Fico at 1200 on the 17th with the center near 16.1°N, 138.9°W.

Fico moved into the central North Pacific, continuing westward at 12 to 15 kn near latitude 16°N. He

Figure 18.--Hurricane Fico at 1/2-mi resolution with 115-kn winds and a well-defined eye on July 17.

passed 150 mi south of the island of Hawaii on the 20th and then turned to the northwest toward an upper level trough of low pressure. Moving over colder water, the cyclone began to weaken rapidly. The final advisory was issued at 1200 on July 28 with the center at 30°N, 179°W. During Fico's lifespan of 468 hr, 79 advisories were issued on the cyclone.

HURRICANE GILMA - JULY 13-20

As Fico moved southwest of Socorro Island on July 11, Gilma was developing 1,100 mi to the east and 350 mi southeast of Acapulco. Moving west-southwestward over 84°F water, the area of convective activity associated with the new disturbance expanded rapidly from a diameter of 300 mi to one of 600 mi in less than 24 hr. By 0000 on the 13th, cyclonic circulation was evident, and the disturbance was upgraded to a tropical depression near 11.4°N, 99.5°W. By 0600 Gilma reached tropical-storm intensity near 11°N, 100.3°W. She moved west-southwestward for 12 hr, then turned westward near 10.5°N, 101.8°W. By 1200 on the 14th Gilma was 490 mi southwest of Acapulco. She turned northwestward, and by 1800 on the 15th Gilma had 65-kn hurricane-force winds near 14.8°N, 109.8°W. She attained maximum intensity of 100 kn by 0600 the next day near 14.9°N, 112.2°W. Convective activity associated with the storm had expanded to a diameter of about 800 mi. Gilma continued to move westward for another 6 hr, then turned west-northwestward to near 15°N, 113.2°W. Infrared satellite imagery showed the cyclone with an eye of 15 mi in diameter. By 0000 on the 17th Gilma had moved to 16.3°N, 114.5°W. The KYOTO and MING LEADER provided much desired observations. Figure 19, with 1/2-mi resolution, shows Gilma south of Baja California near 16.7°N, 116.7°W, at 1626 on the 17th. Continuing west-northwestward, Gilma moved to 18°N, 118.6°W, by 0600 on the 18th. Ninety-knot winds near the center slowly decreased as she moved over colder 79°F water. Low clouds to the northwest also began to move into the low-level circulation, further weakening the hurricane. By 0000 on the 19th the winds had diminished to 55 kn, and Gilma was downgraded to a tropical storm. The MING LEADER, 50 mi north-northwest of Gilma at 1200, reported north-northeasterly winds of 35 kn. By now the winds near the center were 45 kn. Moving over colder 75°F water, the storm weakened rapidly. By 1800 winds had decreased to 25 kn, and the storm was downgraded to a tropical depression near 21°N, 126.8°W. With low

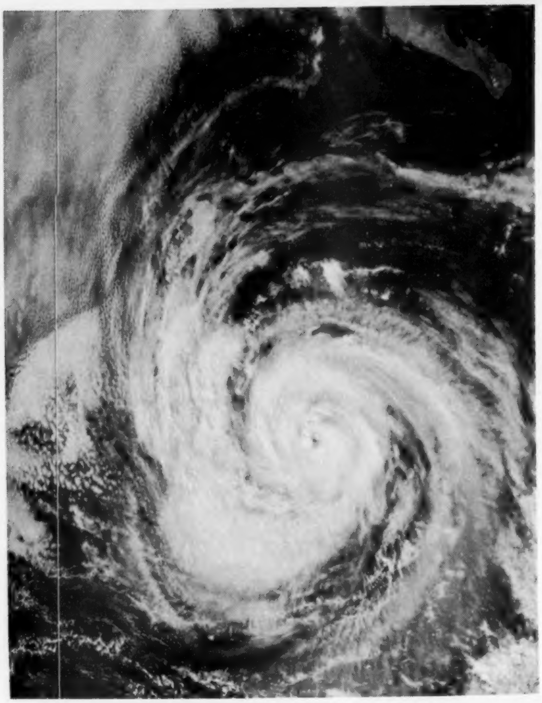

Figure 19.--A polar-orbiting NOAA-5 visible image with 1/2-mi resolution shows Gilma with 90-kn winds 530 mi southwest of the tip of Baja California on July 17.

clouds moving into all but the eastern quadrant, the cyclone dissipated rapidly. The final advisory was issued July 20 with the center near 21.6°N, 128.2°W. About 1,500 mi to the west Fico was just beginning to move south of the Hawaiian Islands.

HURRICANE HECTOR - JULY 22-29

Hector began as a disturbance about 170 mi south of Guatemala on July 19. He moved rapidly west-northwestward at 15 kn for 24 hr, then slowed to 6 kn for the next 24 hr. By 0000 on the 22d a cyclonic circulation had developed, and the disturbance was upgraded to a tropical depression 200 mi south of Acapulco. Moving over warmer water, the depression intensified to tropical-storm strength by 0600 near 13.7°N, 100.7°W. The U.S. Coast Guard cutter NORTHWIND, 150 mi to the northwest, helped locate the storm. By 0000 on the 23d Hector was 200 mi southwest of Acapulco with 60-kn winds; by 1200 the winds had increased to 65 kn, and Hector was upgraded to a hurricane near 15.3°N, 104.1°W. He was now moving westward. At 1800 on the 24th satellite pictures showed a well-defined eye near the center of the hurricane. Figure 20 shows Hector near 16°N, 109.8°W, at 2315 on the 24th. Winds near the center were now 100 kn, and by 0600 on the 25th they reached maximum intensity of 120 kn about 150 mi south of Socorro Island. Hector continued to move westward for another 6 hr, then turned northwestward, reaching 19.8°N, 116.9°W, by 1800 on the 26th. Reports from several ships, the

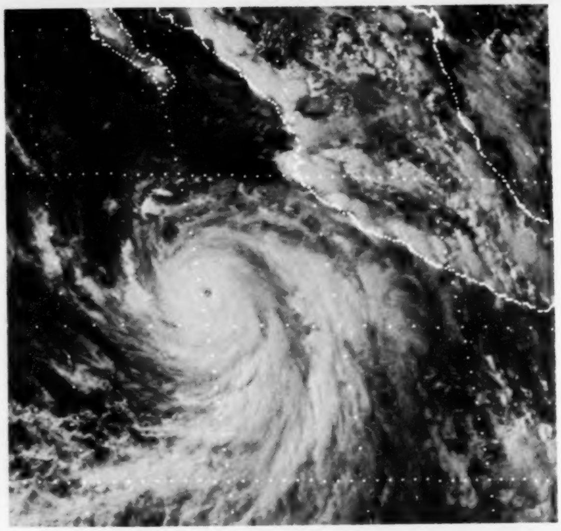

Figure 20.--Hurricane Hector with 100-kn winds on July 24.

MEONIA, PHILIPPINE PRESIDENT GARCIA, NEPTUNE DIAMOND, EXXON BOSTON, and REDSKY, were helpful in locating Hector during the 23d to the 26th. Turning west-northwestward again, Hector began to weaken over 81°F water. Low clouds to the northwest entered the low-level circulation, further weakening the cyclone. By 1800 on the 27th winds had decreased to 60 kn, and the hurricane was downgraded to a tropical storm near 20.9°N, 120.3°W. Hector moved west-northwestward at 11 kn over colder 78°F water. Low clouds spread rapidly around the western and southern quadrants, reducing the winds to 30 kn, and the storm was downgraded to a tropical depression near 22.4°N, 126.1°W, at 0000 on the 29th. As the depression continued west-northwestward, sea-surface temperatures dropped to 74°F. The final advisory was issued July 29 with the center near 23.5°N, 130°W. Remnants of the cyclone drifted westward and were visible on satellite pictures through August 3.

HURRICANE IVA - AUGUST 11-15

Iva began as a tropical disturbance 250 mi southwest of Acapulco on August 9. Moving north-northwestward at 7 kn the disturbance passed 100 mi southwest of Manzanillo, Mexico, during early morning of the 10th. It then turned westward and began to intensify over 82°F water. By 0600 on the 11th infrared satellite pictures showed cyclonic circulation, and the disturbance was upgraded to a tropical depression near 18°N, 108°W. It intensified rapidly. Within 6 hr winds had increased to 45 kn, and the depression was upgraded to a tropical storm at 18°N, 109°W. Iva turned west-northwestward and passed along the southern shore of Socorro Island between 0100 and 0200 on the 12th. She continued to intensify over warm 86°F water. By 0600 on the 13th Iva reached maximum intensity of 65 kn and was upgraded to a hurricane near 20.1°N, 115.7°W. Figure 21 shows Iva with 65-kn winds near 20.8°N, 117.2°W, at 1715 on August 13. Iva continued to move west-northwestward, but she began to weaken over cooler 80°F water. The AMSTELVELD helped locate Iva's

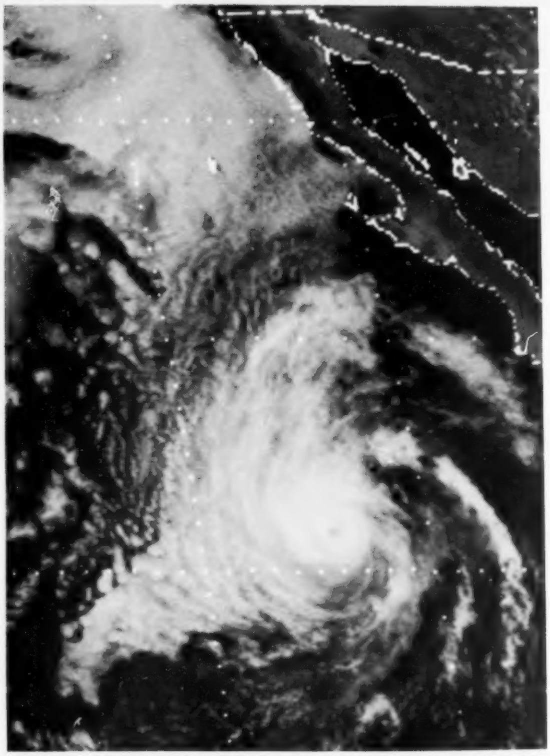

Figure 21.--Hurricane Iva with 65-kn winds on August 13.

center during this period. At 0000 on the 14th Iva was downgraded to a tropical storm with 60-kn winds near 21.1°N, 117.7°W. By the 15th winds had diminished to 30 kn, and the storm was downgraded to a tropical depression near 22°N, 119.6°W. The cyclone then turned northwestward and dissipated rapidly over 79°F water. The final advisory was issued at 0600 with the center near 22.5°N, 120°W, 550 mi west of the tip of Baja California.

HURRICANE JOHN - AUGUST 18-31

As Iva dissipated on the 15th, three new disturbances popped up along latitude 10°N near 104°W, 114°W, and 124°W. The one in the center moved westward for 24 hr then turned west-northwestward and began to intensify. By 0000 on the 18th satellite movie loops displayed a cyclonic circulation, and this disturbance was upgraded to a tropical depression near 12.2°N, 121°W. The depression turned westward again, and with winds now blowing at 35 kn it was upgraded to tropical storm John near 12.3°N, 123.8°W. During this time hurricane Kristy was developing from the disturbance near 104°W, and tropical storm Lane was forming from the one near 124°W. By 1800 on the 19th John had moved to 12°N, 125°W. Figure 22 shows John at 1815 on the 19th, with hurricane Kristy to the east and tropical storm Lane to the west. John turned west-northwestward and continued to intensify. By 0600 on the 22d he was near 15.8°N, 133.6°W. He then turned westward, and at 1200 was upgraded to a hurricane with 70-kn winds near 15.7°N, 134.8°W. Only 18 hr later, however, John was again a tropical storm with 60-kn winds near 15.4°N, 138.2°W. The Eastern Pacific Hurricane Center issued its final advisory on the cyclone at 1200 on the 23d.

John moved into the central North Pacific, passing

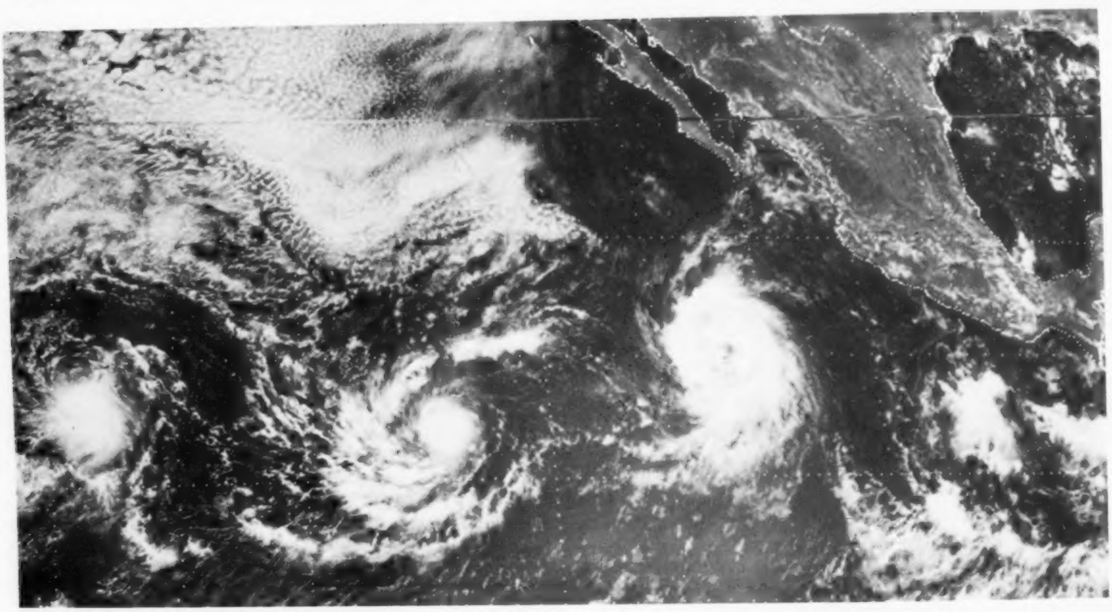

Figure 22.--Tropical storm John is near 12°N, 125°W, at 1815 on the 19th. Hurricane Kristy is 770 mi to the east, and tropical storm Lane is 830 mi to the west.

300 mi south of the Hawaiian Islands on the 27th. He was downgraded to a tropical depression 400 mi southwest of the Islands on the 28th. A final advisory was issued by the Central Pacific Hurricane Center at 0000 on August 31 as John dissipated rapidly about 100 mi southwest of Johnston Island.

HURRICANE KRISTY - AUGUST 18-28

The second disturbance to develop on August 15 began near 10°N, 104°W. Moving northwestward over 81°F water, the disturbance intensified. By 1800 on the 18th satellite pictures showed cyclonic circulation, and the disturbance was upgraded to a depression near 13.6°N, 109.2°W. Winds increased to 40 kn on the 19th, and the depression was upgraded to tropical storm Kristy near 14.1°N, 110°W. The storm, with a well-defined eye, was now about 280 mi south of Socorro Island. By 1800 Kristy had 65-kn winds and was upgraded to a hurricane near 15.5°N, 112.3°W. She reached maximum intensity of 90 kn at 0600 on the 21st near 17.3°N, 117.2°W. Figure 23 shows Kristy near 17.5°N, 117.9°W, at 1215 on the 21st. Tropical storm John can be seen to the west-southwest. By the 22d Kristy had moved to 18.4°N, 119.4°W. She turned westward and began to weaken over 78°F water. Low clouds to the northwest entered the low-level circulation, further weakening the hurricane. By 0600 on the 24th the winds had dropped to 55 kn, and the hurricane was downgraded to a tropical storm near 18.7°N, 130.3°W. Kristy now turned west-northwestward past the low clouds to an area of warmer 81°F water and began to intensify again. By 0000 on the 25th she was again a hurricane with 70-kn winds near 19.8°N, 134.2°W. Winds increased to 75 kn by 0600 but then began to decrease again as the cyclone moved back over water of 78°F. By 1800 Kristy was a tropical storm with 60-kn winds. The final advisory issued by the EPHC on the cyclone was on August 26 at 0600 with the center near 21.3°N, 139.1°W.

Kristy moved into the central Pacific. Winds near

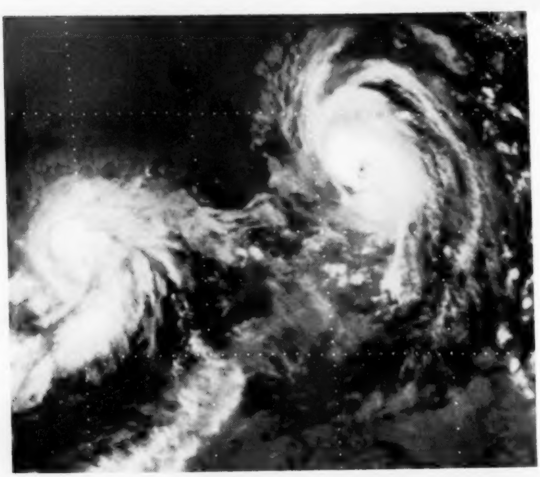

Figure 23.--This infrared image shows hurricane Kristy with 90-kn winds and a well-defined eye 550 mi southwest of the tip of Baja California. Tropical storm John can be seen to the west-southwest.

the center continued to decrease, and she was downgraded to a tropical depression at 0600 on the 27th at 21.5°N, 143.5°W. The CPHC issued its final advisory on the cyclone at 1800 on the 28th with the center 450 mi northeast of the island of Hawaii.

TROPICAL STORM LANE - AUGUST 19-23

The third tropical disturbance to begin on August 15 began near 10.2°N, 124°W. Moving west-northwestward over 81°F water, the disturbance developed slowly. By the 19th satellite movie loops showed cyclonic circulation, and the disturbance was upgraded to a depression near 13.2°N, 135.8°W. The winds increased to 35 kn by 1800, and the depression was upgraded to tropical storm Lane near 13.7°N, 139°W. Figure 24, taken at 1915 on the 19th, shows tropical storm Lane near 13.8°N, 139.1°W. Tropical storm John can be

Figure 24.--This visible image shows tropical storm Lane near 13.8°N, 139.1°W at 1915 on August 19 (1 hr after fig. 22).

seen to the right and hurricane Kristy to the far right. Turning to the northwest, tropical storm Lane moved to 14.4°N, 139.8°W, by 0000 on the 20th. Winds near the center had increased to 45 kn. The storm then turned westward and began to weaken over 78°F water. Winds decreased to 30 kn by the 22d, and the storm was downgraded to a tropical depression. The final advisory was issued at 1800 on the 23d as the center dissipated 280 mi south of the island of Hawaii.

TROPICAL STORM MIRIAM
AUGUST 23 - SEPTEMBER 2

There was a small disturbance 400 mi south of Acapulco on August 19. It moved westward and developed slowly until the 23d. At 1500 satellite pictures showed cyclonic circulation about the center, and the disturbance was upgraded to a tropical depression near 10.9°N, 114.9°W. The cyclone showed little further intensification until the 26th. Satellite movie loops no longer indicated cyclonic circulation; and the depression, moving westward at about 20 kn, was downgraded to a disturbance near 12.1°N, 129°W. At 1800 on the 26th cyclonic circulation was again evident (fig. 25), and the disturbance was upgraded to a tropical depression. Turning west-northwestward, it began to intensify. Early on the 27th the winds had increased to 35 kn, and the depression was upgraded to tropical storm Miriam near 13.2°N, 134.8°W. Miriam crossed into the central Pacific late on the 27th with winds at their maximum

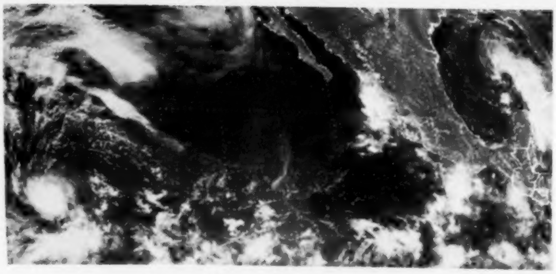

Figure 25.--Tropical cyclone 15 near 12.8°N, 133.5°W, at 1815 on August 26, 6 hr before becoming tropical storm Miriam. Tropical storm Debra is in the Gulf of Mexico.

intensity of 55 kn through 1800 of the 28th. Moving west-southwestward, Miriam passed 220 mi south of the island of Hawaii on the 30th. She dissipated 580 mi southwest of Hawaii by September 2.

HURRICANE NORMAN
AUGUST 30 - SEPTEMBER 6

Hurricane Norman began as a tropical disturbance 400 mi southeast of Acapulco on August 29. Moving westward, the disturbance was upgraded to a tropical depression at 1800 on the 30th near 12.8°N, 98°W. Winds near the center increased rapidly to 40 kn by 0000 on the 31st, and the depression was upgraded to tropical storm Norman near 12.8°N, 98.8°W. Turning toward the west-northwest, Norman continued to intensify. By 0600 on September 1 he reached hurricane strength with 65-kn winds near 14.6°N, 103°W, which is about 230 mi southwest of Acapulco. A small eye was visible on satellite pictures at 1315. The winds continued to increase as Norman moved west-northwestward over 85°F water. By 0000 on the 2d he had 95-kn winds, and 6 hr later 115 kn. The AMERICAN LEGION, ASIA HONESTY, B.T. ALASKA, EAGLE, KUROBE MARU, MAIN EXPRESS, TACOMA CITY, and TEMPLE INN contributed most valuable observations between 0600 on the 1st and 1200 on the 2d. The ASIA HONESTY, only 30 mi north of Norman at 1200 on the 2d, reported 41-ft seas and easterly winds of 93 kn. Norman passed over the northeast coast of Socorro Island between 1700 and 1800 on the 2d. Figure 26 shows Norman with 115-kn winds 25 mi northwest of Socorro Island at 1915. By 0000 on the 3d, Norman reached maximum intensity of 120 kn near 19.8°N, 112.4°W. The first reconnaissance flight of the season penetrated Norman at 2339 on the 2d with a second flight at 0152 on the 3d. The eye of the hurricane was reported to have a closed wall 40 mi in diameter and weak from northeast to northwest. Observations from the ANTONIA JOHNSON, DAMPIER MARU, ERIKA BOLTEN, NEDLLOYD SINOUTSKERK, NORTH HAMPTONSHIRE, OGDEN TIBER, and OVERSEAS JUNEAU between 1800 on the 2d and 0600 on the 3d helped forecasters to better evaluate the storm and to forecast its movement. Norman continued to move west-northwestward at 15 kn under the southwest side of an upper level HIGH centered over the tip of Baja California. As the cyclone moved over cooler water, winds began to diminish. Reconnaissance aircraft flew through Norman again at 1813 on the 3d. This time

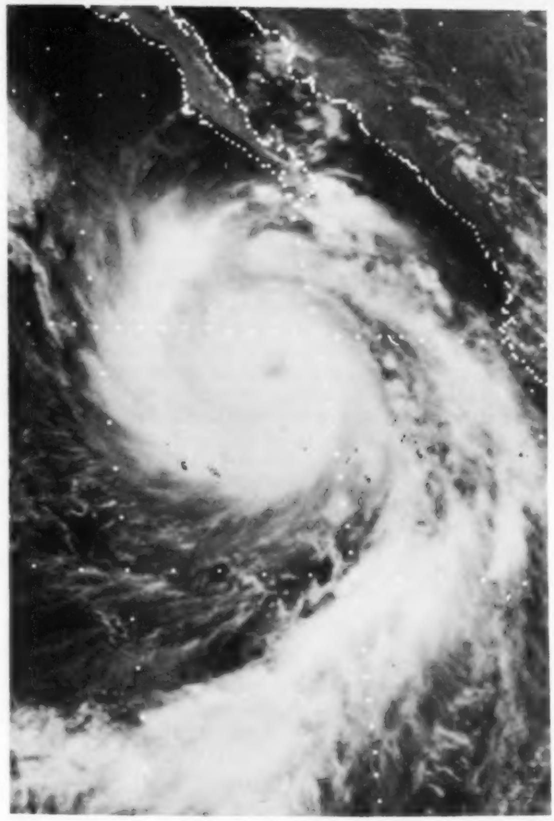

Figure 26.--Hurricane Norman had 115-kn winds on the 2d about 25 mi northwest of Socorro Island.

the eye was reported as poorly defined, and the surface winds, which were estimated from pressure readings, had decreased to 90 kn. Clouds and precipitation spread northward into strong southwesterly flow aloft and were being carried rapidly inland over California on the 4th. Norman was now about 450 mi west of Puerto Magdalena on the Baja California coast. He turned northward while still under the southwest side of the upper level HIGH, which was now centered over extreme northwest Mexico. By 1800 on the 4th Norman's winds had decreased to 50 kn over cooler water, and he was downgraded to a tropical storm near 25.3°N, 120.7°W. Norman raced to 28°N, 120.4°W, by 0600 of the 5th and turned north-northeastward. Reconnaissance aircraft made a final flight through Norman at 1730 on the 5th. Winds, estimated from pressure readings, had decreased to between 30 and 35 kn. By 1800 the cyclone was downgraded to a tropical depression with the center near 30.7°N, 119.1°W. The AQUILA, CHEVRON MISSISSIPPI, FREDERICK LYKES, and TSURUMI MARU were helpful in analyzing the cyclone during this period. Accelerating toward the north-northeast, the depression was weakening rapidly. The final advisory was issued on September 6 with the center 20 mi south of San Clemente Island off the southern California coast.

HURRICANE OLIVIA - SEPTEMBER 20-23

Hurricane Greta moved from the Atlantic Ocean across Central America into the Pacific Ocean. She moved onshore along the Belize coast during the evening of September 19. Moving westward, Greta was downgraded to a tropical storm over northern Guatemala at 1000. She turned west-southwestward over extreme southeastern Mexico and was downgraded to a tropical depression 90 mi inland from the Pacific coast at 1800. The first advisory on the cyclone was issued by the EPHC on the 20th with the center still 30 mi inland from the coast. As the depression moved offshore over 83°F water, it began to intensify. By 0600 the winds had increased to 35 kn, and it was upgraded to a tropical storm near 15°N, 94°W. As an eastern North Pacific cyclone, the storm was named Olivia. By 1200 the storm had moved to 14.6°N, 95°W. It turned northward, and the winds increased to 55 kn. Olivia then reversed course and began to drift slowly toward the south. The NORDKAP, 30 mi from the center at 0500 on the 21st, reported 55-kn winds. Olivia continued to intensify as she moved southward. Figure 27 shows Olivia with 60-kn winds near 13.9°N, 95°W, at 1815 on the 21st. The SIJILMASSA, 60 mi from the center at 2200, reported 45-kn winds and rough seas. Radar on the ship fixed Olivia's center near 14°N, 95°W. By 0000 on the 22d, Olivia's winds had increased to 65 kn over 86°F water, and the storm was upgraded to a hurricane. The PACIFIC PRINCESS reported 60-kn winds within 30 mi of Olivia's center. The hurricane remained near 14°N, 95°W, until 0600, then turned north-northeastward and began to weaken over 83°F water. Her winds decreased to 50 kn by 1800 and Olivia was downgraded to a tropical storm near 15.9°N, 94.3°W. She was dissipating rapidly only 10 mi off the coast of the Gulf of Tehuantepec. The storm moved onshore 50 mi east of Salina Cruz on the Gulf of Tehuantepec between 1900 and 2000. The final advisory on the cyclone was issued on the 23d with the center 30 mi inland from the coast near 16.5°N, 94°W. Winds near the center had diminished to between 20 and 30 kn.

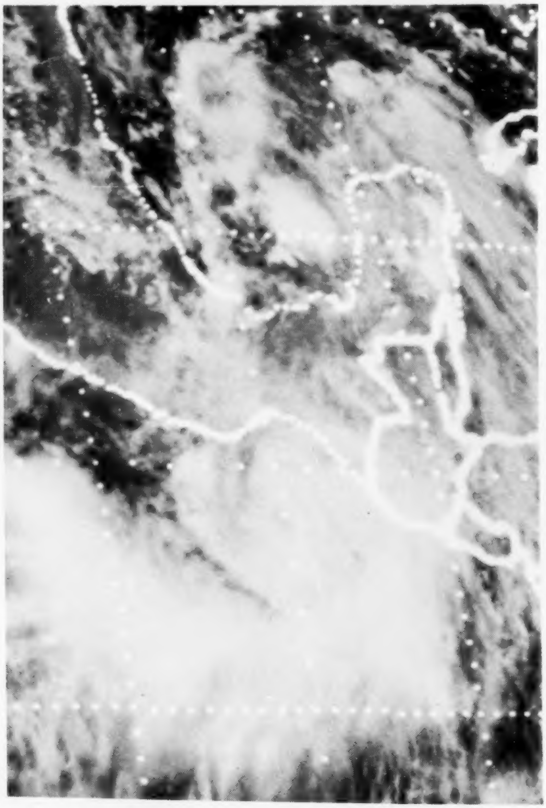

Figure 27.--Tropical storm Olivia is over the Gulf of Tehuantepec on September 21.

TROPICAL STORM PAUL - SEPTEMBER 23-26

Paul began as a disturbance near the Mexican coast and 200 mi west-northwest of hurricane Olivia on September 22. Moving southwestward, the disturbance was upgraded to a tropical depression near 14.1°N, 100.5°W, at 0000 on the 23d. It then turned west-northwestward and moved to 19.3°N, 108.8°W, by 0600 of the 25th, showing little intensification. The AMERICAN LIBERTY, CHESHIRE, DAISHIN MARU, LADY JOSEPHINE, MASON LYKES, NEDER ELBE and the PACIFIC DARBY contributed observations which were of great value to the analyst. Turning to the north-northwest, the depression began to intensify. By 1200 of the 25th the winds had increased to 35 kn, and the depression was upgraded to tropical storm Paul. The cyclone was now 120 mi northeast of Socorro Island and 160 mi south of the tip of Baja California (fig. 28). Paul turned northward, and winds near his center reached their maximum intensity of 40 kn on the 26th. The EXXON BOSTON and PACIFIC transmitted helpful observations. Turning toward the north-northeast, the storm passed 25 mi east of the tip of Baja California between 0100 and 0300. As it moved toward the coast

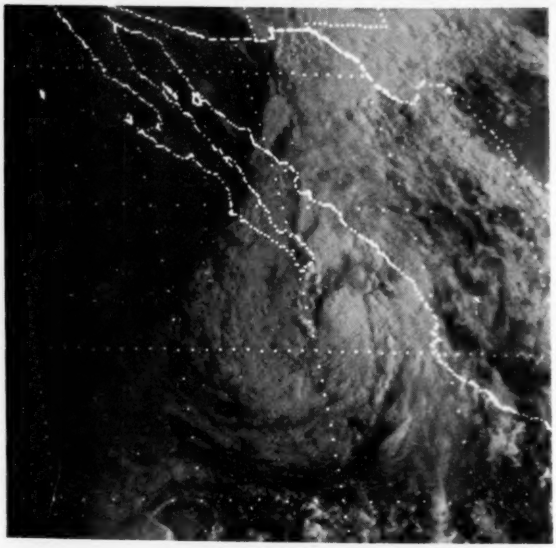

Figure 28.--An early morning visible satellite picture shows tropical storm Paul 130 mi south of the tip of Baja California at 1415 on September 25.

of Mexico, it began to weaken. By 1200 on the 26th winds had decreased to 30 kn, and the storm was downgraded to a tropical depression off the Mexican coast near 25°N, 108.2°W. Remnants of the cyclone dissipated over northern Mexico.

HURRICANE ROSA - OCTOBER 2-7

This storm began as a tropical disturbance 300 mi south of the Gulf of Tehuantepec on October 1. Moving west-northwestward at 12 kn, the disturbance began to develop between two centers of convective activity 150 mi apart. Turning counterclockwise about each other, the two centers merged into one large center, 250 mi in diameter, near 13.2°N, 101.4°W, by 1200 on the 2d. Cyclonic circulation could be seen by 1800, and the disturbance was upgraded to a tropical depression 250 mi southwest of Acapulco. The depression turned toward the northwest and, while moving over 84°F water, continued to intensify. By 0000 on the 3d the winds had increased to 45 kn, and it was upgraded to tropical storm Rosa near 14.9°N, 103.7°W. Figure 29 shows Rosa with 55-kn winds near 17.5°N, 107.5°W, at 2315. She was a hurricane by early on the 4th near 17.6°N, 107.6°W. Rosa continued to intensify as she moved around the west side of an upper level HIGH centered over Mexico. By 1800 winds reached maximum intensity of 75 kn 100 mi east of Socorro Island. The ships MEMNON, NORDHVALL, PAGNOL, and PUERTOVALLARTA were helpful in locating Rosa. The hurricane continued northwestward for another 12 hr, then turned northward and began to weaken over 81°F water. The ROYAL VIKING STAR, SANTA MERCEDES, and the SVENDBORG MAERSK broadcast valuable observations on the 5th. Reconnaissance aircraft made three penetrations into Rosa on the 5th at 1420, 1530, and 1615. The eye, which was open to the southwest, was described as elliptical with a 30-mi major axis oriented from northeast to southwest. The surface winds as estimated from pressure ranged from 60 to 70 kn. By 1800 Rosa's winds had decreased to 60 kn, and she was downgraded to a tropical storm near 21.3°N, 109.9°W, about 100 mi south of the tip of Baja California. The storm moved northward for another 12 hr, then northwestward, and began to weaken rapidly over colder water. By 1800 on the 6th winds near the center were 25 kn, and the cyclone was downgraded to a tropical depression near 22.8°N, 110.6°W. The final advisory was issued on October 7 with the center about 60 mi west of the tip of Baja California.

TROPICAL STORM SERGIO - OCTOBER 18-20

The final cyclone of the season began as a disturbance 350 mi southeast of Socorro Island on October 18. It moved westward at 5 kn and showed little intensification for the first 12 hr. It then turned northwestward and began to intensify rapidly over 84°F water. Winds reached 35 kn by 1800, and the disturbance was upgraded to tropical storm Sergio about 20 mi southeast of Socorro Island. The FREDERICK LYKES and PRAG were helpful in analyzing Sergio at this time. Sergio accelerated northwestward to 18.7°N, 110.7°W, by 1200 on the 19th (fig. 30). With winds remaining at 35 kn, he crossed over Socorro Island between 1300 and 1400. Sergio began to weaken, and by 0600 on the 20th his winds had decreased to 30 kn. He was downgraded to a tropical depression near 21.7°N, 113.9°W. The cyclone turned northward and weakened rapidly over colder water. The ALIOTH and NORDKAP supplied valuable observations. The final advisory for this storm and for the season was issued at 1800 on October 20.

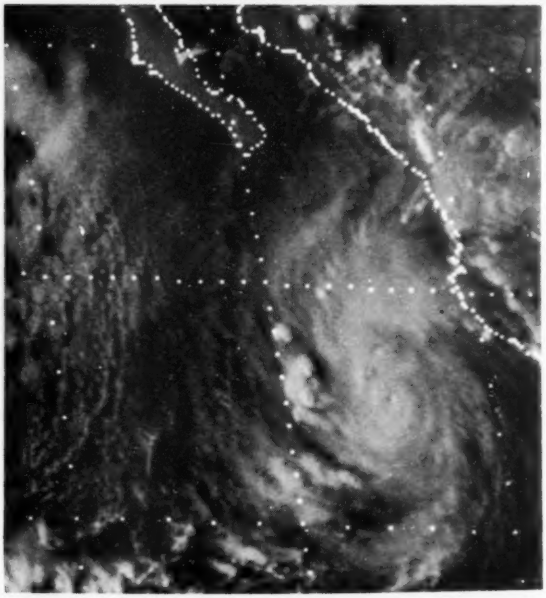

Figure 29.--Tropical storm Rosa, 45 min before becoming a hurricane, late on October 3.

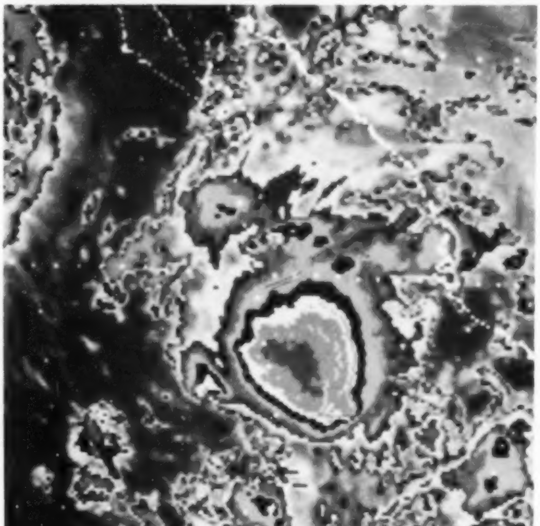

Figure 30.--This enhanced infrared satellite image shows tropical storm Sergio 20 mi southeast of Socorro Island and 270 mi south of the tip of Baja California.

Mariners Weather Log

CENTRAL NORTH PACIFIC TROPICAL CYCLONES, 1978

Samuel L. Shaw
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Honolulu, Hawaii

Without question 1978 was the year of greatest tropical-cyclone activity in the central North Pacific on record. Thirteen cyclones or their readily identifiable remnants entered or formed in the area which extends from longitude 140°W to the International Date Line and northward from the Equator. The season not only set a record for number of occurrences but also produced a storm with an exceptional length of travel and persistence of hurricane intensity (Fico), as well as one of the two most-intense hurricanes on record in the central North Pacific area (Susan). Figure 31 shows the tracks of the various tropical cyclones which entered the Central Pacific Hurricane Center's (CPHC) area of responsibility during the 1978 season.

Table 6 is a chronological listing of the season's various events. Dates pertinent to central Pacific activity are given for each cyclone. Vortices listed are those storms which entered the central Pacific as unique systems. Each is the weakened stage of a tropical cyclone which originated in the eastern North Pacific and was tracked by GOES-3 satellite imagery into the central Pacific. Two of these vortices were tracked completely across the central Pacific and into the western Pacific. All of them were accompanied by significant weather, which varied from clusters of thunderstorms to extensive areas of heavy rainfall, and were

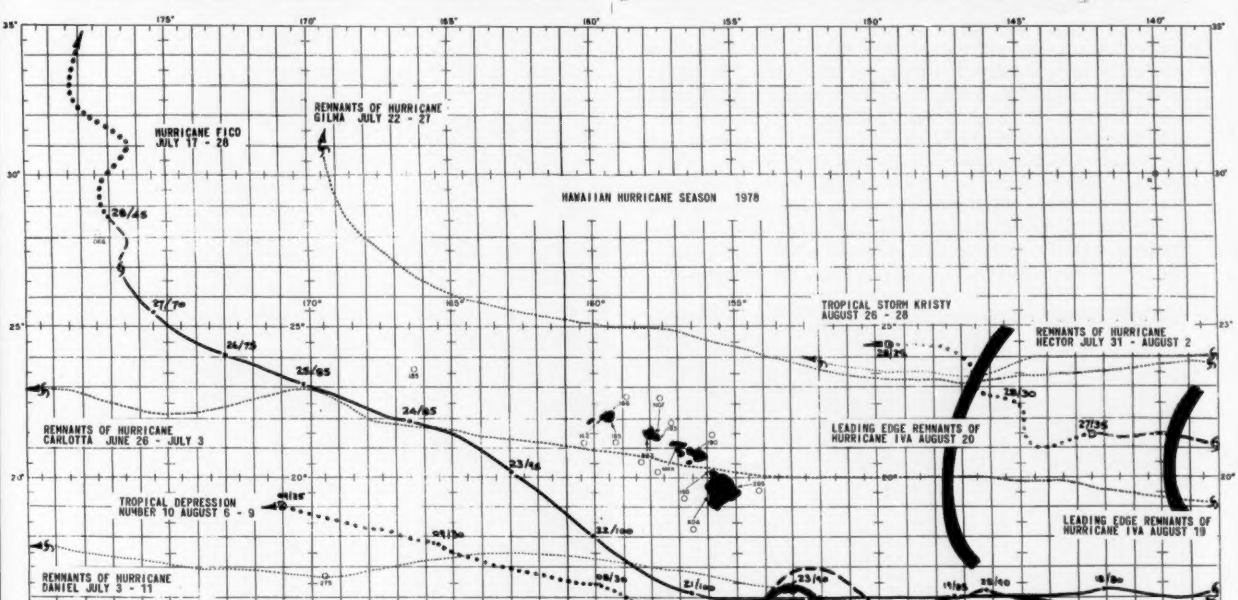

Figure 31.--Tropical cyclone tracks over the central North Pacific during 1978.

Table 6.--Central North Pacific tropical-cyclone data, 1978[1]

Name	Dates	Maximum Class	Maximum sustained winds (kn)	Lowest pressure (mb)	Total hours observed
Bud	June 24-26	Vortex	N/A	N/A	48
Carlotta	June 26-July 3	Vortex	N/A	N/A	168
Daniel	July 3-11	Vortex	N/A	N/A	192
Fico	July 17-28	Hurricane	100	955	225(H) 15(TS) 36(ET)
Gilma	July 22-27	Vortex	N/A	N/A	144
Hector	July 31-Aug. 2	Vortex	N/A	N/A	60
T.D. 10	August 6-9	Tropical Depression	E30 (NESS)	N/A	84
Iva	August 19-21	Vortex	N/A	N/A	54
John	August 23-30	Hurricane	90	965	48(H) 72(TS) 48(TD)
Kristy	August 26-28	Tropical Storm	E50 (NESS)	N/A	18(TS) 45(TD)
Lane	August 20-23	Tropical Storm	E50 (NESS)	N/A	66(TS) 27(TD)
Miriam	Aug. 27-Sept. 2	Tropical Storm	E55 (NESS)	N/A	72(TS) 6(TD)
Susan	October 18-24	Hurricane	120	954 (recce) 945 (Dvorak)	81(H) 30(TS) 24(TD)

Total hours observed per class -	hurricane	354
	tropical storm	273
	tropical depres.	150
Total hours tropical-cyclone activity (all classes)		777
Total hours vortices with significant weather		750
Combined total		1,527 hours

Key

H	hurricane
TS	tropical storm
TD	tropical depression
ET	extratrppical
NESS	satellite estimate

[1]All data pertain only to the period while the storm was in the central Pacific.

designated as tropical disturbances in forecasts issued by the National Weather Service Forecast Office in Honolulu.

BUD - JUNE 24-26

The central Pacific season began with Bud, which had been a tropical storm east of longitude 140°W. Remnants of Bud reached 14°N, 140°W, as a tropical disturbance, then abruptly turned southwestward and died in the Intertropical Convergence Zone (ITCZ) on June 26.

CARLOTTA - JUNE 26-JULY 3

Figure 32 shows the condition of the vortex which was the weakened stage of hurricane Carlotta on June

Figure 32.--The remains of ex-hurricane Carlotta approach the Hawaiian Islands on June 27.

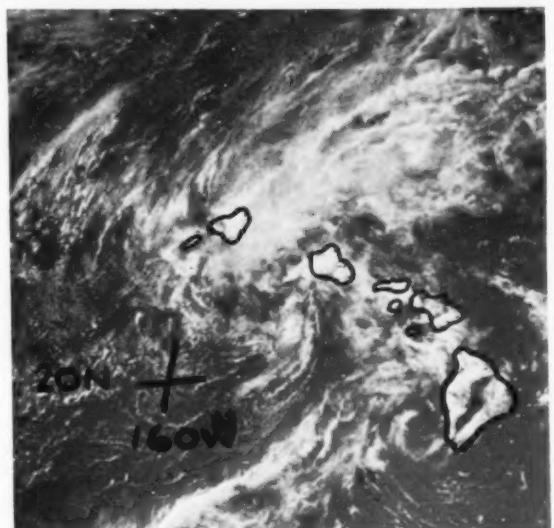

Figure 33.--Ex-Carlotta 24 hr later after generously soaking the island chain with copious rainfall.

27 just before its impact on the Hawaiian Islands. The ex-hurricane passed across 19°N, 140°W, and proceeded nearly straight westward along 20°N. The center of the vortex passed over the Alenuihaha Channel between the Big Island of Hawaii and the island of Maui on June 28. Figure 33 shows the vortex and its accompanying weather pattern 24 hr later as viewed by CPHC fore-

casters and National Environmental Satellite Service (NESS) meteorologists. During its travel across the length of the island chain it produced heavy rainfall over much of the area north of the center, but there was no appreciable increase in windspeeds. Rainfall amounts in many areas were as high as 6 in (152 mm), especially over the island of Oahu. As far as the Hawaiian public was concerned, Carlotta was one of the major weather producers of the season.

Carlotta's remnants continued to be clearly identifiable as a tropical disturbance on GOES-3 imagery as the storm proceeded westward. It was tracked to longitude 170°E, where it merged with a cold LOW aloft. It continued to move westward to near Marcus Island (24°N, 154°E) on July 10.

DANIEL - JULY 3-11

On July 3, the same day that the remains of Carlotta left the central Pacific, ex-hurricane Daniel entered the eastern side of the area at 16°N also as a tropical disturbance. This vortex moved westward (like that of Carlotta but on a slightly more southerly track) across the entire central Pacific between latitudes 16°N and 17°N. Definite dissipation of the vortex did not occur until it approached 19°N, 171°E, on July 12. Figure 34 illustrates the extensive mass of cloudiness, showers, and thunderstorms which accompanied this vortex. On July 6 the cloud mass encompassed nearly 180,000 mi^2 and was of much concern to aviation and shipping interests. At this time the Honolulu forecast staff anticipated another episode of heavy rainfall over the entire island chain. Windward sections of the Big Island and Maui did receive 5 to 7 in of rain from ex-Daniel, but rainfall over windward and mountain sections of the other islands was quite spotty and generally under the 2-in mark. Figure 35 shows how the well-structured, massive weather pattern associated with ex-hurricane Daniel was broken up by the "barrier effect" of the Hawaiian Islands. Resultant divergent low-level wind flow caused the leeward portions of the Islands to remain mostly fair.

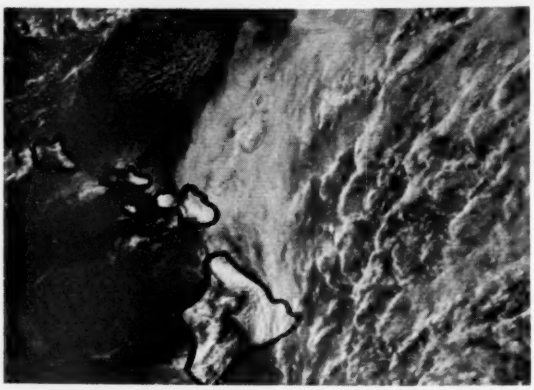

Figure 34.--Ex-hurricane Daniel on July 6. There is a massive area of cloudiness, showers, and thundershowers associated with the vortex. which is near 16°N, 150°W.

Figure 35.--The extensive weather pattern which had been associated with the vortex 25 hr earlier was severely fractured by the "barrier effect" of the Hawaiian Islands.

HURRICANE FICO - JULY 17-28

Fico entered the central Pacific at 16°N, 140°W, on July 17 with maximum sustained winds near 80 kn. He previously had peaked at 115 kn in the eastern Pacific east of the 140th meridian. Fico proceeded along the 16th parallel to a point due south of South Point, Hawaii, the southernmost part of the Big Island. U.S. Air Force reconnaissance and NESS satellite imagery observed a steady increase in Fico's intensity during his travel from 140°W to the position south of South Point. The RACHEL was sailing eastward north of Fico near 142°W on the 18th, where she encountered 50-kn winds and swell waves of 41 ft.

Surf from the open-ocean swell generated by Fico began to rise on July 18, with some beach road flooding along the southeast coast of the Big Island when the hurricane was 500 mi to the southeast. The high surf was a combination of east-northeasterly swell from the hurricane and strong southerly swell from a Southern Hemisphere storm. By the next morning Civil Defense officials reported 30-ft (9.1 m) surf breaking well offshore with lesser 15- to 20-ft short-period surf doing considerable damage to beachfront homes and roads along Big Island shores. Figure 36 is a GOES-3 visual pic-

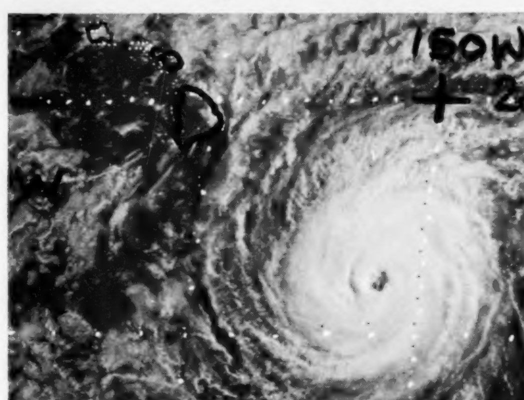

Figure 36.--Hurricane Fico at 1748 on July 19. At this time high surf was damaging beachfront homes and roads on the southeast coast of the Big Island of Hawaii.

Figure 37.--The grounded 65-ft tugboat LIHUE III is pounded by heavy surf from hurricane Fico. The Garden Island photo by Pickard.

Figure 38.--This surfer got a good ride on the high surf produced by Fico. Surfers were probably the only ones happy about the approach of the hurricane. The Garden Island photo by Pickard.

ture of Fico taken on July 19, when the hurricane posed a definite threat to Hawaii. Surf of 8 to 12 ft was observed on eastern Maui by noon of the 19th, with water over roads in that area but no damage reported. Very short-period surf of similar heights reached southern Oahu and southern Kauai on the following day (figs. 37 and 38). Six people aboard the 43-ft sloop DIASTOLES were rescued by a Navy torpedo boat after the sloop lost its auxiliary power off Hanalei, Hawaii, and was unable to make headway in the 50-kn winds. The 65-ft tugboat LIHUE III went aground on a reef at Kukuiula in high seas.

Figure 39.--Hurricane Fico on July 20 with maximum sustained winds of 100 kn. This was enlarged from the same type imagery used in figure 36.

The configuration of Fico as viewed from GOES-3 on July 20 is sharply outlined in figure 39. At this time the eye of the hurricane was 175 mi south-southwest of South Point with maximum sustained winds of 100 kn. The CHEVRON GENOA, which had been following Fico, measured 36-kn winds, 10-ft seas, and 16-ft swells about 100 mi to the northeast. Fico had already begun moving northwestward, maintaining 100-kn winds until he was 190 mi southwest of Kauai. Subsequently, Fico very slowly lost intensity. At 2100 on the 21st the TOWNSEND CROMWELL fought 35-kn winds and 15-ft seas southwest of Oahu. A strong trade wind gradient, increased by the proximity of Fico, caused gusty winds over all the islands with numerous reports of 50 kn or more, accompanied by falling trees and power outages.

Fico maintained hurricane intensity for 17 days. He was tracked by the Honolulu and San Francisco National Weather Service forecast offices (with much support from their respective NESS units) for approximately 5,000 mi. On the 28th the MING LEADER found 55-kn winds northeast of Midway Island after Fico had turned extratropical. Even in his dying stages Fico did not want to give up. Remnants of the storm, enmeshed in a strong cold frontal system, inflicted heavy rain and up to 40-kn winds on ships to the southeast of Cold Bay in the Aleutians on July 31.

GILMA - JULY 22-27

At the same time that Fico was 215 mi southwest of Kauai on July 22, the remnants of hurricane Gilma entered the central Pacific at latitude 23.8°N. This well-defined vortex proceeded westward between the 23d and 24th parallels until it reached 155°W, the longitude of the island of Hawaii. It then took a west-northwestward track and passed 180 mi to the north of Oahu and Kauai on the 24th. From that point the vortex moved northwestward and dissipated near 31°N, 164°W, on July 27.

The satellite imagery in figure 40 shows the vortex of Gilma centered 300 mi northeast of Hilo, Hawaii, while the eye of hurricane Fico is clearly discernible at very nearly an equal distance to the west-southwest of Lihue, Kauai. This picture clearly shows one reason the forecast staff at Honolulu diligently keeps tracking these vortices. The Gilma disturbance covers an area from 20°N to 30°N between 147°W and 155°W, a total of 300,000 mi^2. Its wind field, as well as the associated shower and thunderstorm activity, is of great importance to numerous ships and light aircraft traversing the central Pacific.

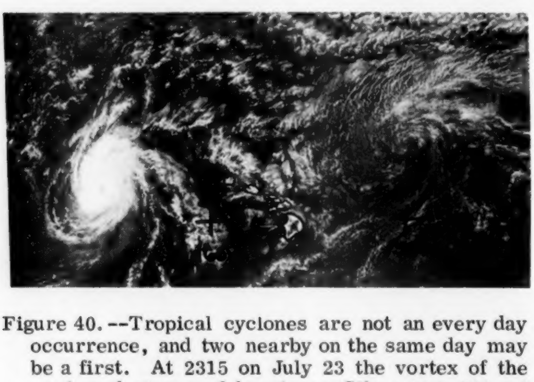

Figure 40.--Tropical cyclones are not an every day occurrence, and two nearby on the same day may be a first. At 2315 on July 23 the vortex of the weakened stages of hurricane Gilma was 200 mi northeast of Hilo at the same time the eye of hurricane Fico was nearly equidistant to the west-southwest of the island of Kauai.

HECTOR - JULY 31-AUGUST 2

The remnants of hurricane Hector entered the central Pacific near 24°N and for 2 days took the same track as the vortex of Gilma had taken 9 days earlier. Since there had been little change in the general synoptic situation throughout the area during that time, it seemed that the history of this vortex would be similar to Gilma's. But Hector rapidly dissipated just 300 mi northeast of the island of Hawaii on August 2.

TROPICAL DEPRESSION 10 - AUGUST 6-9

The next tropical cyclone in the area developed in a very active portion of the ITCZ at 11°N, 145°W, on August 5. By the next day it was classified as a tropical depression. Since it originated in the central Pacific, it was given a number by the Joint Typhoon Warning Center (JTWC) at Guam--number 10. Some confusion developed since the Eastern Pacific Hurricane Center was following another tropical depression numbered 10 at the same time.

GOES-3 imagery (fig. 41) showed the center of the depression 300 mi south-southwest of the island of Oahu. Maximum winds associated with this cyclone were never greater than 30 kn; however, it generated an extensive area of rainfall with some embedded very heavy thunderstorms. Heavy rains began on August 6 on the island of Hawaii and spread westward over the island chain through the 8th. Rainfall amounts generally averaged 3 to 5 in.

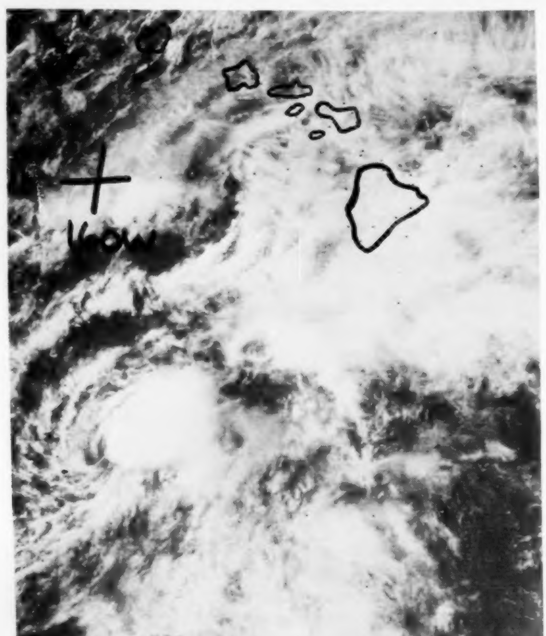

Figure 41.--Tropical depression 10, 300 mi south-southwest of the island of Oahu late on August 7.

IVA - AUGUST 19-21

Iva had a rather unusual lifespan in the central Pacific. On August 19 the leading edge of a massive cloud and shower shield associated with the diffuse remnants of Iva reached 140°W (fig. 42). Twenty-four hours later the rain shield was caught in the trade winds, and its edge moved 8° of longitude to the west ahead of the parent vortex (fig. 43). One day later the rain shield reached the eastern shores of the Big Island and Maui (fig. 44) with many areas reporting 5 to 6.5 in. Little was left of Iva thereafter.

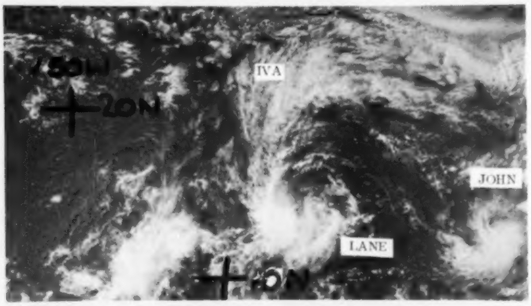

Figure 42.--The leading edge of the massive cloud and shower shield associated with the remnants of hurricane Iva reached 140°W early on August 19. Lane is directly south.

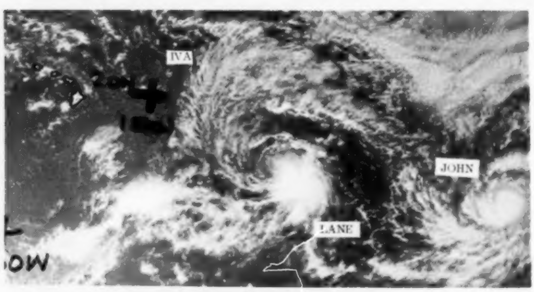

Figure 43.--The remnants of Iva are moving westward north of developing tropical storm Lane at 0015 on the 20th.

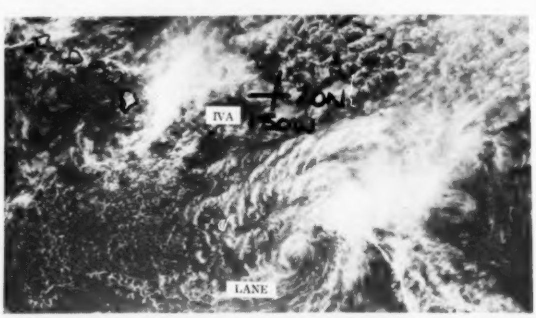

Figure 44.--The remnants of Iva are approaching the Islands late on the 21st. Tropical storm Lane is to the southeast.

HURRICANE JOHN - AUGUST 23-30

Hurricane John and tropical storms Kristy and Lane became named storms at the same time on August 19 in the eastern Pacific. A GOES-3 photo (fig. 45) depicts the interesting situation on August 27. John had reached maximum strength with sustained winds of 90 kn on the 24th near 16°N, 146°W, and then he steadily weakened. At the time of the photo he was 225 mi to the south-southwest of the Big Island, classified as a tropical storm with maximum sustained winds of 35 kn. He weakened to depression intensity on the morning of the 28th. He was caught in the trades and then meandered west-southwestward to 170°W, where he was last identified on August 30.

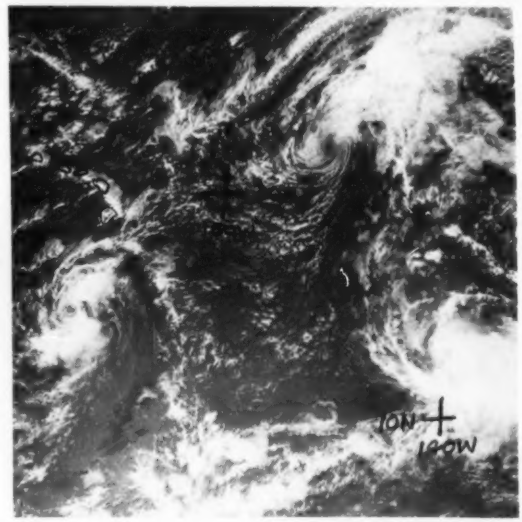

Figure 45.--If two tropical cyclones near Hawaii at the same time seems odd, three is even more so. Tropical storm John is 240 mi southwest of South Point, Kristy is 600 mi north-northeast of Hilo, and tropical storm Miriam is 925 mi to the southeast.

TROPICAL STORM KRISTY - AUGUST 26-28

Kristy entered the central Pacific near latitude 21°N with 45-kn winds and an area of active thunderstorms to the northeast. This storm described a pronounced sinusoidal northwestward track, while gradually weakening, but continued to be accompanied by significant weather of concern to maritime and aviation interests. At 2315 on August 27, Kristy was downgraded to a tropical depression, but she still affected ship and air routes to the mainland United States. She rapidly disintegrated during the next 24 hr and lost her identity on August 28.

TROPICAL STORM LANE - AUGUST 20-23

On August 19 tropical storm Lane was centered further west than hurricane John and tropical storm Kristy, which explains why he entered the central Pacific ahead of the others and out of alphabetical order. The center of tropical storm Lane reached the central Pacific near 14°N on August 20 with maximum sustained winds, near their peak for this storm, of 50 kn. He proceeded nearly due west and gradually weakened--dying out 360

mi south-southwest of the Big Island on the 24th with no appreciable effect on island weather.

TROPICAL STORM MIRIAM
AUGUST 27-SEPTEMBER 2

Miriam moved from the eastern Pacific into the central Pacific with maximum sustained winds of 55 kn, while Kristy and John were still active cyclones (fig. 45). Miriam entered at a point (13°N, 140°W) farther south than any of the other storms which entered from the eastern Pacific. On August 29 Miriam took a heading which threatened the Big Island of Hawaii, and public advisories were issued. But the next morning the storm abruptly changed course and turned to the southwest, eliminating the threat. Miriam kept her tropical-storm classification until she was about 400 mi south of the island of Kauai; thereafter, she decayed quite rapidly.

HURRICANE SUSAN - OCTOBER 18-24

With the demise of Miriam, the Honolulu forecast staff thought that possibly the central Pacific season was over. But on October 18 a suspicious area on the ITCZ southeast of Hawaii rapidly developed into a full-fledged tropical storm. This was the capricious Susan, the last storm of the season. Susan developed tropical-storm strength at precisely the same location where Bud, the first storm of the season, had died (10°N, 145°W).

On October 21 Susan became one of the two most-intense hurricanes on record in the central Pacific. Her maximum sustained winds of 120 kn equalled those attained by Celeste in August 1972. Figure 46 illustrates the character of Susan at 0249 on the 22d during her most-intense stage. The NICKEL I ran into 50-kn northeasterlies on the 23d more than 400 mi northeast of the eye. At that time Susan posed a very real threat to the Hawaiian Islands. After moving 220 mi southeast of the Big Island, Susan turned sharply to the southwest and disintegrated very rapidly. Once again the Islands were spared! The pressure rose more than 50 mb in 24 hr with the onset of strong upper wind shear.

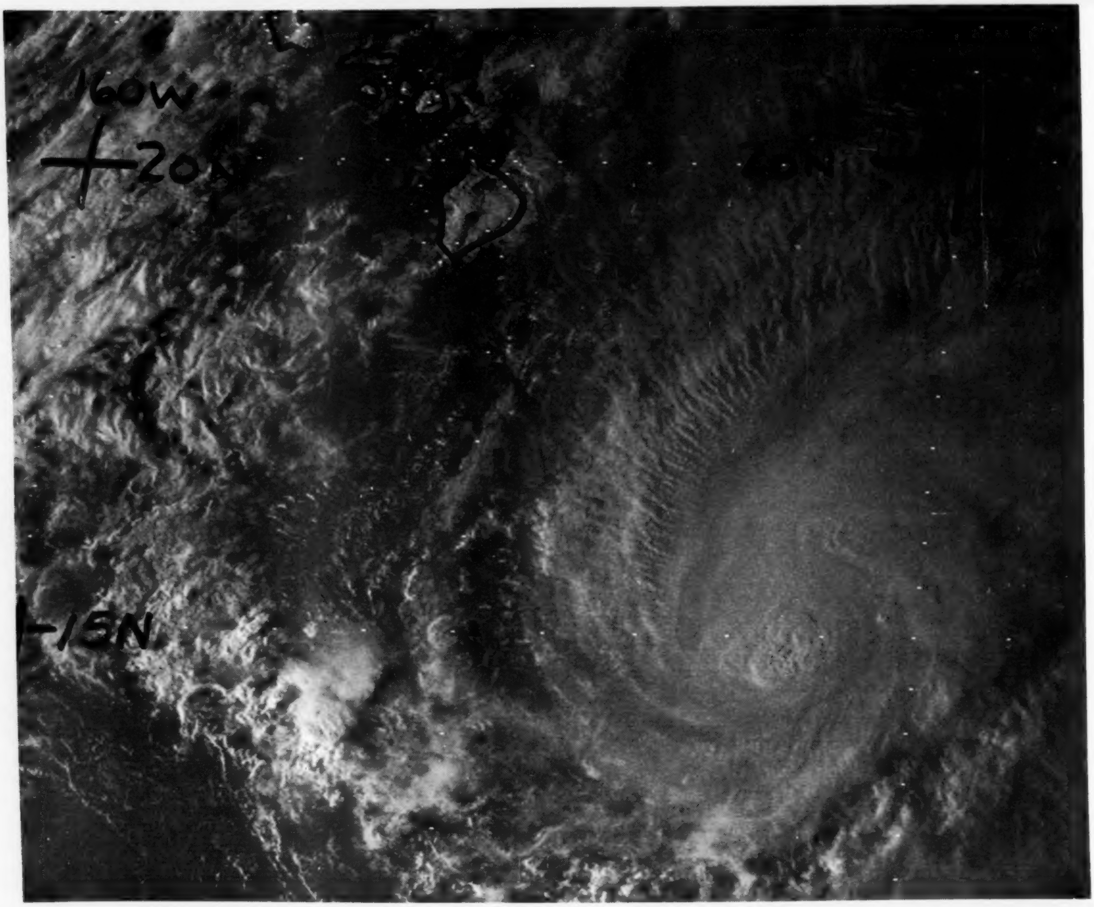

Figure 46.--Hurricane Susan during her most-intense stage as darkness approached on October 22. At this time maximum sustained winds were 120 kn.

Hints to the Observer

HURRICANE REPORTING

Dear Captain:

I'd like to remind you that the hurricane season (June through November) is near. In order for us to provide adequate warnings, we need your cooperation in providing weather observations in the vicinity of hurricanes and tropical storms.

To assist our forecasters in determining storm location, intensity, and movement, we would like you to:

1. Make and transmit reports at least at 3-hr intervals when within 300 mi of a tropical storm or hurricane.

2. Include in "Remarks" the lowest pressure and/or the highest wind encountered if, since the last synoptic report:

   a. The pressure was more than 5mb lower, and/or

   b. The wind was more than 15 kn higher than the present value(s).

   Also, include the time of occurrence.

   Example: 0800Z LOWEST PRESSURE 970MB 0730Z HIGHEST WIND 85KN.

I've enclosed copies of "General Instructions for Radio Reporting of Weather Observations" for your use.

The National Weather Service appreciates the time and effort you and your officers give to provide reports of weather conditions at sea. Your reports are extremely important considering the vast ocean spaces and the relatively few ships that report weather.

Sincerely,

Richard E. Hallgren
Director, National Weather Service

GENERAL INSTRUCTIONS FOR RADIO REPORTING OF WEATHER OBSERVATIONS

Standard Synoptic Observation Times--The regular weather-reporting hours are 0000, 0600, 1200, and 1800 GMT. Occasionally, watch schedules or priority of other duties make it impractical to make and transmit surface observations at standard synoptic times. To ensure message transmission, observations may be made in advance of the weather-reporting hours. In these cases, the actual time of observation should be included in the report.

Coded Weather Messages--All messages to be transmitted by radio should be transcribed from the ship's weather log to NOAA Form 72-4, "Weather Report for Immediate Radio Transmission," in the World Meteorological Organization (WMO) ship synoptic code FM21V or FM23V and given to the Radio Officer.

Transmission of Radio Messages--Weather messages should be transmitted as soon as possible to the most convenient radio station in accordance with instructions contained in "Radio Stations Accepting Ships' Weather and Oceanographic Observations."

Weather Message Addresses for Transmission to U.S. Radio Stations--Use "OBS METEO WASHDC" when in the:

1. Western North Atlantic, including the Gulf of Mexico and Caribbean Sea, north of 3°N latitude, and west of 35°W longitude (WMO Region IV-A).
2. Eastern North Pacific (north of the Equator), east of the 180th meridian (WMO Region IV-A).
3. Eastern South Pacific (south of the Equator), from the South American coast to 120°W longitude (WMO Region III-B).

Use "OBS METEO GUAM" when in the western North Pacific between 5° and 25°N latitude, and from 135°E to the 180th meridian (WMO GUAM ZONE).

Observations During Storm Conditions--Whenever TROPICAL STORM, TYPHOON, or HURRICANE conditions are encountered anywhere, "SAFETY OF LIFE AT SEA CONVENTION," Chapter V, requires all ships to take a special observation and transmit the report to the closest national meteorological service via the most convenient radio station. In addition to this requirement, it is highly desirable that weather reports be transmitted hourly if possible, but, in any case, not less frequently than every 3 hr.

Special Requests for Observations--During storm situations, the U. S. National Weather Service may request ships located in areas of suspected storm development to take special observations at more frequent intervals than the routine 6-hr synoptic observation times. If your ship happens to be in such an area, your report will be helpful even though conditions may not appear bad enough to warrant a special observation. To speed delivery of messages from storm areas and to identify them as such, the word STORM should appear immediately following the ship's call sign in the radio address. An example of the message format is: "OBS METEO WASHDC ABCD STORM 99305 70750," etc.

Observations in Coastal Waters--Since radio weather reports are always needed from ships in coastal waters, observations should continue to be taken as close to shore as ship routine permits.

Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

U. S. COAST GUARD BROADCAST CHANGES

The U.S. Coast Guard has rescheduled the medium frequency CW marine information broadcast as follows:

Station	Times (GMT)	
Commsta Boston (NMF)	1450	0000
Commsta Portsmouth (NMN)	1520	0020
Radsta Miami (NMA)	1500	0050
Radsta New Orleans (NMG)	1550	0100
Radsta San Juan (NMR)	1430	0030

This change is intended to provide a more convenient schedule for one-operator ships. The Coast Guard is also making limited use of SITOR/ARQ (Simplex teletype over radio-direct printing/automatic repeat request) for Ice Patrol Bulletins from Commsta Boston (NIK). The SITOR broadcast immediately follows the CW broadcast schedule at 0018 and 1218 GMT.

In the Pacific, a SITOR/ARQ guard has been established at Commsta San Francisco (NMC) as follows:

RCV	XMT	Times (GMT)
8353.5 kHz	8714.5	0000 - 2400
12501 kHz	13081	0300 - 1900
16670 kHz	17207	1900 - 0300

CORRECTIONS TO WORLDWIDE MARINE WEATHER BROADCASTS (July 1977 Edition)

Change MF CW broadcast times as listed above for stations 1-0150, 1-0200, 1-0210, 1-0240 and 1-0270.

The new edition of Worldwide Marine Weather Broadcasts has been submitted for printing. Corrections received during the period that the new edition is in press will be summarized in the next issue of Mariners Weather Log.

CORRECTIONS TO RADIO STATIONS ACCEPTING SHIPS' WEATHER AND OCEANOGRAPHIC OBSERVATIONS

Page 8 - NMO Honolulu
Delete frequency 16909.7, insert 22476.

NMC San Francisco
Delete frequencies 12743 and 22476.

MARINE HURRICANE ADVISORIES AVAILABLE ON WU FYI SYSTEM

Commencing June 2, 1979, and continuing through the hurricane season, Marine Hurricane Advisories (WHCA21-25 KMIA) will be available to TELEX and TWX users via Western Union's FYI system.

The areas covered by these Marine Hurricane Advisories are the Gulf of Mexico, Caribbean, and the western North Atlantic Ocean. Once a hurricane is detected and throughout the life of the hurricane, the National Weather Service will update the FYI data base every 6 hr (or more often when necessary). When there is no hurricane activity, a short message to that effect will be stored in the FYI data base. Information on all hurricanes will be reported when more than one hurricane is active at the same time.

To access the FYI data base TELEX users can dial 8513 and TWX users dial 710-988-5956. After exchange of answerbacks, the user types HURRICANE to obtain the Marine Hurricane Advisories.

ACKNOWLEDGMENTS

Thanks to Kenneth Stuber, COVE EXPLORER, and Edward Shanks, TILLIE LYKES, for recent information relative to the marine weather program.

Hurricane Alley

Dick DeAngelis
Environmental Data and Information Service, NOAA
Washington, D.C.

AUSTRALIA - SOUTH PACIFIC JANUARY AND FEBRUARY 1979

On the average seven tropical cyclones, of which three reach hurricane strength, form during January and February. This year was as close to average as you can get. Activity was centered in the New Hebrides-Solomon Islands region (fig. 47), where four tropical cyclones roamed. The Coral Sea and Gulf of Carpentaria were affected by two systems, while another tracked east of the International Date Line.

Gordon, one of two hurricanes, brought his 70- to 75-kn winds close to the northern New Hebrides on January 6 and 7. Kerry, the other hurricane, traveled a crazy path (fig. 48). Her maximum winds reached 80 kn on the 20th. About this time she began to turn a clockwise loop; at the end of this maneuver she was down to tropical-storm strength. A few days later she repeated this performance along the Great Barrier Reef off Queensland. Two tropical storms, Henry and Judith, formed within a week of each other and took similar tracks on either side of the New Hebrides Is-

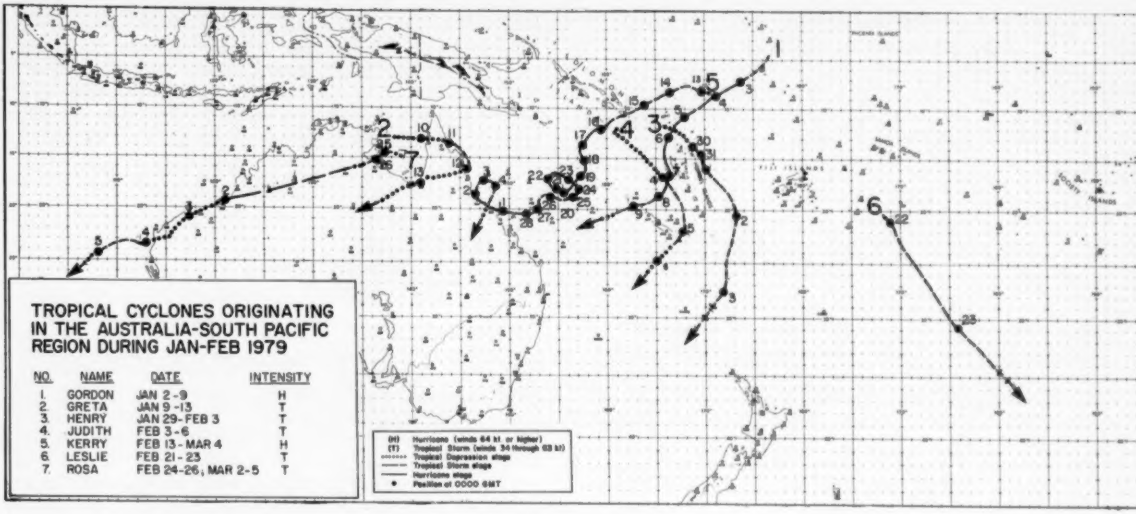

Figure 47. --Tracks of Australia-South Pacific tropical cyclones, January and February 1979.

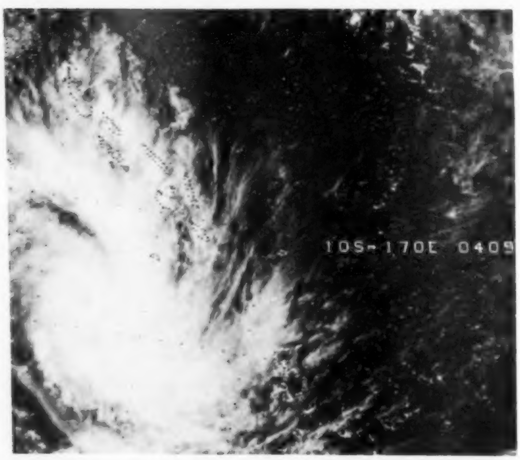

Figure 48. --Kerry among the Solomon Islands on the 17th.

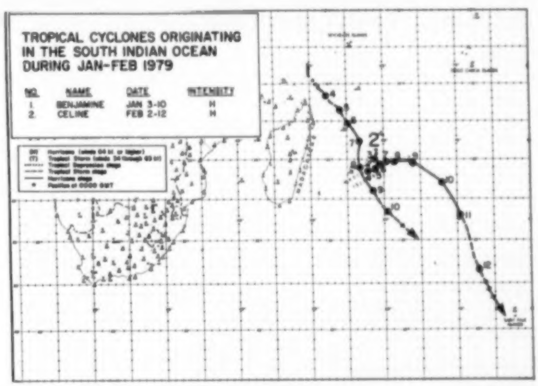

Figure 49. --Tracks of South Indian Ocean tropical cyclones, January and February 1979.

lands. Henry had maximum winds of about 50 kn on February 2, while Judith reached 40 kn on the 4th.

Leslie was a rapidly moving tropical storm that formed south of Samoa on February 22. Her winds climbed to 55 kn as she sped rapidly southeastward. The following day Leslie crossed the 30th parallel and turned extratropical. The Gulf of Carpentaria spawned Greta in early January and Rosa in late February. Greta did not reach tropical-storm strength until across the Cape York Peninsula and into the Coral Sea, where her winds briefly fluttered to 35 kn. Rosa reached 55 kn before she moved onshore over the Northern Territory. She tracked all the way across the Great Sandy Desert as a barely recognizable cloud mass before reaching the rejuvenating waters off Western Australia. They spurred Rosa briefly back to tropical storm life on the 4th, the the following day she fell apart.

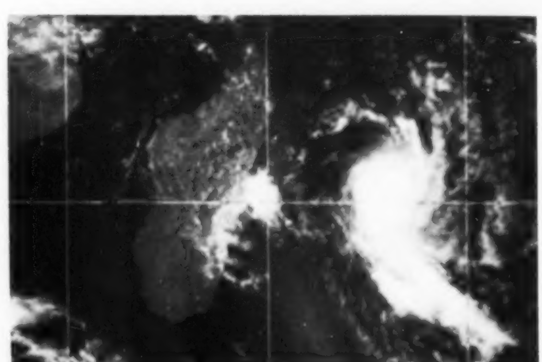

Figure 50. --East of Madagascar, Gordon blankets the Mascarene Islands on the 7th.

SOUTH INDIAN OCEAN
JANUARY AND FEBRUARY 1979

Activity was below normal in the South Indian Ocean. Two tropical cyclones, both hurricanes, roamed these waters (fig. 49). Benjamine formed early in January and moved through the Mascarene Islands, where Celene developed about a month later. Both moved south-southeastward. Benjamine reached minimal hurricane intensity on the 6th, according to satellite information, and remained at that level through the 8th (fig. 50). Celine was the stronger of the two. Satellite photos indicated her winds reached 100 kn during February 8 through 10.

On the Editor's Desk

MORE NATIONAL WEATHER SERVICE AWARDS

Early this year National Weather Service "Special Service Awards" were presented to the Coast Guard Radio Station, San Juan, and the Coast Guard stations at Cape San Juan and Venice, Fla. The presentations were made by Jose A. Colon, Meteorologist in Charge of the Weather Service Forecast Office at San Juan, and Walter A. Sitarz, the Port Meteorological Officer at Miami, Fla. (figs. 51 and 52).

Figure 51.--J. W. Allen, Officer in Charge, U.S. Coast Guard Station at Cape San Juan, is presented the award by Jose Colon, Meteorologist in Charge, NWS Forecast Office at San Juan.

Figure 52.--The station personnel at the U.S. Coast Guard Loran Station, Venice, Fla., with the most important member in the foreground.

CASUALTIES ABOARD U.S. COMMERCIAL VESSELS

A total of 7,118 ships were involved in 4,268 casualties during the 12-mo period ending September 30, 1978, according to a tabulation contained in a recent issue of the Proceedings of the Marine Safety Council. Storms or adverse weather were the primary cause of 360 casualties, and unusual currents were the primary cause of 24 more. There were 179 deaths and 119 injuries as a result of 154 ship casualties. Capsizings, founderings, and floodings caused the most casualties, 59, with 119 deaths and 15 injuries. Of the 154 casualties causing deaths and injuries, storms or adverse weather was the prime cause in 22 cases, currents the cause in 1 case.

In addition to the above deaths and injuries, there were 319 deaths and 1,440 injuries aboard ships not involved in ship casualties. Natural causes accounted for 118 of these deaths, 98 persons fell overboard and drowned, and 4 deaths were primarily attributed to weather conditions. Seventy-five injuries were a direct result of weather.

Casualties involving commercial vessels are required to be reported to the U.S. Coast Guard whenever the casualty results in any of the following: (1) actual physical damage to property in excess of $1,500; (2) material damage affecting the seaworthiness or efficiency of a vessel; (3) stranding or grounding; (4) loss of life, or (5) injury causing any person to remain incapacitated for a period in excess of 72 hr, except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty.

A NEW GLOBAL SEA-SURFACE TEMPERATURE ANALYSIS

In December 1978, the National Meteorological Center (NMC) began producing synoptic, global sea-surface temperature analyses. On alternate days, reports covering the Northern or Southern Hemispheres are analyzed on polar stereographic grids having mesh lengths of 202.6 km at 80° (N/S) and 102.1 km at the Equator. The analyses combine direct sea-surface temperature reports received from ships and buoys (both anchored and drifting) with remote measurements made by satellites.

The satellite data, currently obtained from the ITOS series of NOAA satellite and soon to be obtained from TIROS-N, typically provide about 40,000 reports over the globe daily. Each report represents a 2,500 km^2 area of the ocean surface. For the analysis grid which is used at NMC, this could result in more than 25 reports influencing a single grid point. Therefore, the reports are processed before being used for analysis purposes in order to reduce the number influencing a single grid point.

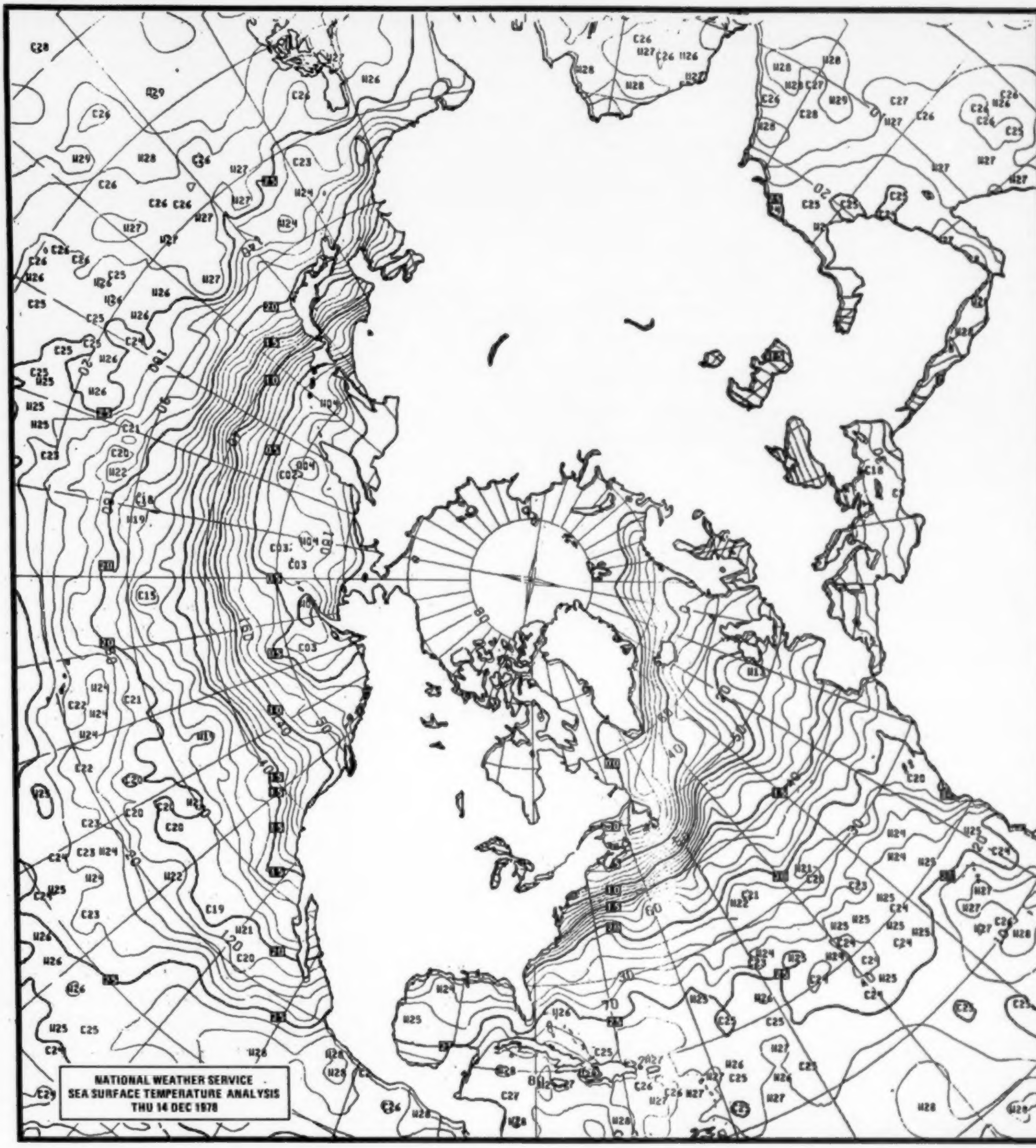

Figure 53.--Northern Hemisphere sea-surface temperature analysis, December 14, 1978.

The NMC is interested in sea-surface temperature (SST) because of the important role that the oceans play in the "manufacture" of weather patterns--especially in the Tropics. Accurate synoptic analyses of sea-surface temperature are required for weather forecasting for coastal and open-ocean areas, for forecasting the development of hurricanes, and in extending weather forecasting for periods longer than a few days.

An objective analysis is used to combine several thousand irregularly distributed measurements of SST onto a map covering the oceans of the Northern or the Southern Hemispheres. The objective analysis technique used by NMC consists of two steps. The first step is to establish a reliable "first guess" field. The first guess is the sum of the present anomaly field and the long-term average field. The magnitude of the present anomaly field (the anomaly field is the difference between the most recent analysis and the long-term average field for the date) is constrained to lie within limits dependent upon the data coverage during the past 10 days.

The second step is the correction of the first-guess field with recent observations. Data are error checked against the first guess, and, if an observation does not differ from the first guess by greater than a certain amount, it is used as a correction. A percentage of each correction is applied to each of the surrounding grid points, the percentage being proportional to the distance between the grid point and the observation. At the conclusion of the correction phase, all noncorrected grid points unaffected by observations are modified.

A numerical procedure known as "conditional relaxation" is used to spread the influence of the observations over the entire grid. This is accomplished by forcing the structure of the new analysis field to match that of the first guess at all noncorrected grid points. In mathematical terms, this amounts to using the Laplacian of the first-guess field as the forcing function for the conditional relaxation.

The analyses are now available at NMC in their standard field format, as graphical hardcopy charts by mail, and on the Global Telecommunications System on a grid of 5° latitude/longitude intersections. An example of the analysis is shown on figure 53.

SEATTLE PMO EARNS BRONZE MEDAL

Donald L. Olson, Port Meteorological Officer in Seattle, Wash., received the Department of Commerce Bronze Medal in February 1979 for his outstanding performance in the marine program. The citation that accompanied the award read as follows:

"As Marine Assistant and Port Meteorological Officer, Donald Olson has been exceptionally effective over a long period of time in the support of National Weather Service programs for marine data acquisition. He has consistently demonstrated unusual initiative and creative ability in technical and administrative procedures. His tact and diplomacy have been instrumental in establishing and maintaining a high degree of cooperation between the National Weather Service and other agencies, companies and organizations involved in the maritime industry. The unique rapport he has developed with masters, mates, and radio operators of merchant vessels of all nations, and the genuine enthusiasm with which he approaches every aspect of his job has enabled him to be unusually successful in the generation of meteorological data from the high seas."

Figure 54.--Don Olson with his Bronze Medal.

The award (fig. 54) was presented at a well-attended luncheon by DeVon Smith, Marine Program Leader from the Weather Service Regional Headquarters in Salt Lake City.

PORT OF VALDEZ OIL SPILL SAFETY RECORD

The port of Valdez, where tankers are loaded with Alaskan oil, has an exceptional safety record, according to the U.S. Coast Guard at the Valdez Marine Terminal. There have been only five spills totalling 34 gal from the oil terminal and 47 spills totalling 800 gal from ship-loading operations in the 1-1/2 yr the port has been open. Three spills accounted for about 550 gal of that amount. Only 20 barrels have been spilled out of 400 million barrels shipped so far.

The port's safety record was discussed in a report to an international oil spill conference sponsored by the Coast Guard, the American Petroleum Institute, and the Environmental Protection Agency.

The oil terminal in Valdez accounts for about half of the Coast Guard's inspection workload, and most of the ships using the terminal are boarded frequently. Tanker personnel who work in Alaska have become used to Coast Guard procedures and correct most of the safety problems before the Coast Guard boards a ship.

There has also been a marked decline in the number of safety violations found by the Coast Guard in Valdez. Of 77 deficiencies found, 41 were related to cargo safety requirements, 20 for general material deficiencies, and 16 for lifesaving equipment or for other reasons.

Tanker operators serving Alaska have shown that it is possible to operate with a minimum number of spills and that oil can be kept on board if proper precautions are taken.

Lightering operations off the coast of southern California have also had an impressive safety record. No major spills and relatively few safety violations have been found during tanker inspections. Since lightering operations began in the area in mid-1976, the Coast Guard has monitored more than 70 instances of lightering. Frequent lightering operations are needed due to the large number of oil refineries in southern California, the lack of deepwater ports for very large crude carriers, and the large amount of crude oil now being transported from Alaska.

With no firm plans for building either new deepwater ports or very large crude carrier offshore moorings, it appears that lightering operations will continue for some time.

HARDANGER RESCUES GOLAR BORG CREW

The story and pictures below were sent to Julius Soileau, Port Meteorological Officer, Houston, Tex., by Hans Lossiusgt, 2d Officer of the HARDANGER. The following is an edited version of the story, condensed from his letter.

The HARDANGER was on a voyage from Swansea to Tampico. On October 31, 1978, they had contact with the GOLAR BORG at 1620. The GOLAR BORG had developed a bad list and requested ships receiving the message to standby. The weather was poor with northwesterly winds gusting up to strong gales. The HARDANGER used RDF to get a bearing on the GOLAR BORG and set that course with much pitching and roll-

Figure 55.--The GOLAR BORG had at least a 45-degree list when this photograph was taken the next morning after the rescue.

Figure 56.--The GOLAR BORG from the starboard side.

ing. The ANTARIOS was also in the area and using crossbearing information obtained a position for the GOLAR BORG. It took the HARDANGER 4 hr to transit the 50 mi to the GOLAR BORG at 38.5°N, 40.5°W (figs. 55 and 56),, arriving about 2130.

The crew of the GOLAR BORG had abandoned ship. They were in a rubber raft and used a hand flare to be spotted. The HARDANGER passed the GOLAR BORG at 2200 and went straight to the raft. They had several misses but finally hooked the raft on the leeward side. Even though the ship had a heavy roll it only took 45 min to get 22 people on deck. All the crewmembers of the HARDANGER were working and did a very good job. The 1st engineer jumped into the raft to help. The raft was also taken aboard.

The people had been in the raft about 2 hr, and they had had a very bad time clearing their ship. One lifeboat was sent out from the GOLAR BORG with four crewmembers, but it did not clear the ship and was smashed near the bow. A search was conducted throughout the night, but no one was found. The following day's position indicated they had drifted about 20 mi during the night. Other ships had responded, and the BRANDS FIELD among others helped in the search. The weather had improved, but the swell was still high. At 1800 on November 1 the HARDANGER sailed for Bermuda, where the rescued crewmembers were put ashore. The GOLAR BORG was reported still afloat 10 days later but finally disappeared.

The crew of the HARDANGER did an outstanding job in the tradition of the sea.

NATIONAL WEATHER SERVICE PUBLIC SERVICE AWARDS

The National Weather Service Public Service Award was presented to U.S. Steel vessel CASON J. CALLAWAY and the U.S. Coast Guard Group at Duluth, Minn., for their contributions to public safety last September 6, when the CALLAWAY encountered a squall, with

winds over 50 kn, out of Duluth Harbor. The CALLAWAY radioed the Duluth Coast Guard, which in turn broadcast the information to small craft and dispatched a picket boat to warn sailing vessels in the Harbor area. The Duluth Weather Service Office precluded regular broadcast on KIG-64 with information on the squall for a period of about 1/2 hr. At the time of the squall about 50 sailing vessels were out, participating in the weekly Wednesday night sailboat races. All small craft reached safe shelter with no serious incidents. (See Mariners Weather Log, November 1978, p. 416.)

Captain Perry S. Klumph, Captain of the CALLAWAY, and Petty Officer Mike Swanson, U.S. Coast Guard, accepted the Award at ceremonies at the Duluth Coast Guard Station on December 26, 1978 (fig. 57). Captain Klumph retired a few days later. The CALLAWAY has been an excellent weather reporter for many years.

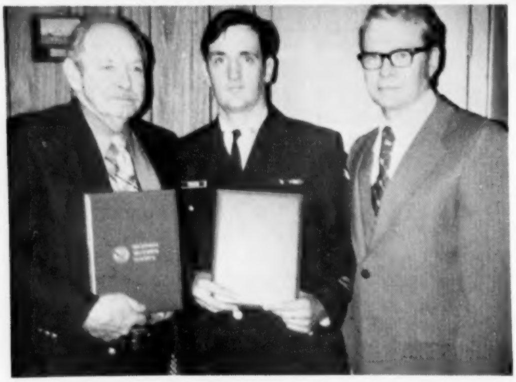

Figure 57.--Captain Klumph and Petty Officer Swanson with their awards.

The Atlantic Richfield Company (ARCO) and six of its ships have been presented the Public Service Award (fig. 58) for significant contributions to the public safety and welfare through the taking of shipboard weather observations and, more significantly, participation in an experimental program of transmitting the observations to the National Weather Service via the MARISAT satellite. This communications system is proving to be very successful in substantially reducing transmission times and communications errors in shipboard observations.

The ships were:

ARCO ANCHORAGE	ARCO JUNEAU
ARCO FAIRBANKS	ARCO PRUDHOE BAY
ARCO HERITAGE	ARCO SAG RIVER

The following is extracted from a letter from the Director of the National Weather Service to Captain Charles M. Lynch of Atlantic Richfield:

"It was through efforts of personnel on these ships that we now obtain rapid transmission of weather reports utilizing the satellite. Observations made by your ships are now reaching NWS forecast offices usually in less than 20 minutes, well in advance of those sent by conventional means.

"These ships ply one of the worst weather routes

Figure 58.--Tony Rippo, PMO Long Beach, and ARCO officials at the award ceremonies.

in the Pacific. Yet, they're the best weather reporters in the NWS cooperative observing ship program, making almost twice as many observations as other ships.

"On behalf of the National Weather Service, I'm pleased to present to the Atlantic Richfield Company and each of these ships, our Public Service Award."

ECLIPSE OF THE SUN

Figure 59 shows how the eclipse of the Sun by the moon appeared on the Earth as viewed from SMS satellite at 36,357 km above the Equator at 135°W. The dark area around Lake Winnipeg shows the area of maximum eclipse with the Sun reflecting off the snow and clouds both to the east and west.

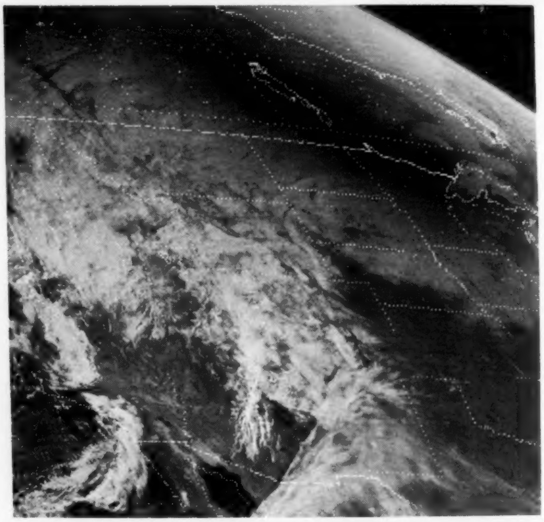

Figure 59.--This is what the satellite observed at 1645 February 26, 1979.

ICE DATA FOR ALASKA - CORRECTION

An item concerning an update on ice breakup and freezeup in Alaska appeared in the January 1979 issue.

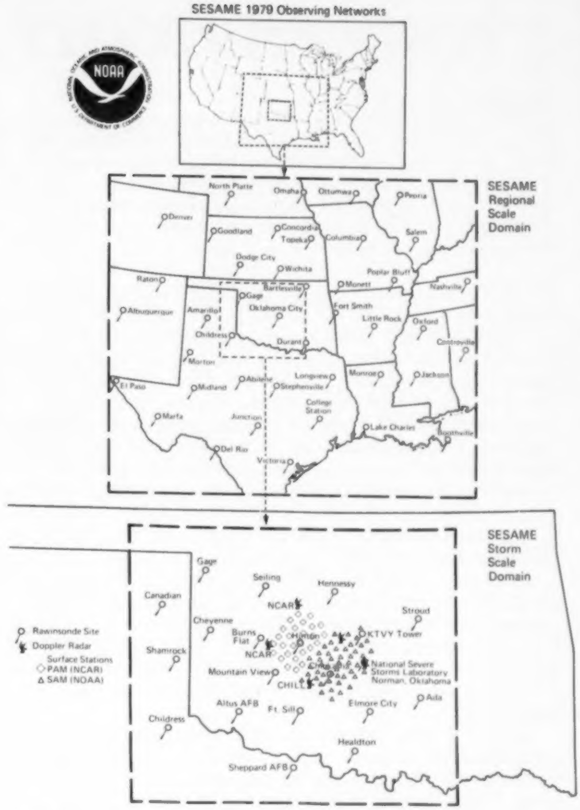

Figure 60.--SESAME Observing Networks.

The item stated that data collection stopped in 1971. According to James L. Wise, Alaska State Climatologist, the data has been published through 1975 in the Climatological Data for Alaska. The published data will be updated in the near future using this new information.

BUOY DEPLOYED IN GREAT LAKES

The first in a network of automatic buoys to help weather prediction around the Great Lakes was recently deployed in Lake Superior. The all-aluminum, boat-shaped buoy will provide general weather-forecasting information especially useful to ships and boats on the Lakes.

The buoy is 20 ft long, weighs 20 tons, and has an 18-ft mast on which are mounted many sensors to measure windspeed and direction, air temperature, barometric pressure, surface water temperature, and wave height and period.

The buoy automatically will transmit this information every 3 hr to a central unit at the National Weather Service in Suitland, Md., for retransmission to weather stations in the United States and Canada. During severe storm conditions, the buoy can be commanded by remote signal to report every hour.

RESEARCH PROJECT PROBES WEATHER IN GREAT PLAINS

A $3.9 million cooperative experiment began the first week in April over the Great Plains to improve scientific understanding of small-scale weather--weather ranging from midlatitude cyclones to tornadoes and "microweather" of metropolitan areas.

Called SESAME, for Severe Environmental Storms and Mesoscale Experiment, the project ran through May and was managed by NOAA's National Severe Storms Laboratory in Norman, Okla. NOAA and the National Science Foundation are providing most of the funding.

The experiment focuses on a regional scale, nominally a square 1,100 mi on a side, centered on Norman (fig. 60). Within that large region, stations operated by the National Weather Service, supplemented by 19 special sounding sites, are providing wind velocity balloon soundings of the atmosphere every 3 hr as evolving weather systems occur. At the same time, SESAME scientists scrutinize data from NOAA's geostationary satellites for high-resolution, high-frequency pictures of the study area, and from the TIROS-N satellite with its temperature-sounding system. Researchers hope to get at least three 24-hr-long case studies of storm systems at this scale.

A small air force from NOAA's Research Facilities Center, the National Center for Atmospheric Research (NCAR), the University of South Dakota, and the National Aeronautics and Space Administration (NASA) provided airborne platforms needed in the experiment. Some of these aircraft flew thunderstorm penetrations, perhaps the roughest flying available in the atmosphere.

In May the study area was reduced to a storm-scale square 250 mi on a side. Existing rawinsonde stations in the regional-scale network continued to provide 3-hr soundings on experimental days, while some special rawinsonde sites were drawn inward into a dense network covering much of Oklahoma and northern Texas. Additional aircraft from the Air Force and the South Dakota School of Mines and Technology joined the SESAME squadron. Doppler radars swept an area dotted with a dense network of automatic surface weather stations. Any storm system that crossed this minefield of instrumentation was measured, probed, and remotely dissected to an unprecedented degree.

From this storm-scale work, scientists expect to gain a more complex view of the prestorm environment and the origins of severe thunderstorms and tornadoes, related boundary-layer processes, the role of shortwave troughs in triggering or intensifying convective storms, how the storm interacts with the atmospheric environment, and the harsh dynamics within the evolving storm itself.

One of the first priorities of SESAME is to study the development of convection from its very early stages, trace its evolution and decay, and follow development of complete storm systems. This will certainly contribute to scientific understanding of these events. There will also be some short-term benefits, such as tests of newly developed predictive models at NOAA, NCAR, and several universities using SESAME data; improvements in computer modelling techniques of clouds; and perhaps even the ability to develop closely detailed forecasts of afternoon events from morning data.

One of the important tests of SESAME data will come at the National Severe Storms Forecast Center in Kansas City, Mo., the source of severe-storms

guidance for the United States. There, 6 mo after the fact, meteorologists will rerun some simulated storm days, basing their forecasts on both conventional data and enhanced data from SESAME, to determine the impact of SESAME-type information on warning operations. The next step for a concept of a concentrated study of weather at the mesoscale could be a more complete experiment along larger lines in the early 1980's, one that would bridge both to the larger and the smaller scales of time and space not spanned this year.

GLOBAL WEATHER EXPERIMENT PROVIDING UNPRECEDENTED DATA

World weather maps are being dramatically transformed by the Global Weather Experiment, a unique year-long international scientific effort to monitor the Earth's oceans and atmosphere. During a recently completed 5-week intensive observing period, a massive array of aircraft, ships, satellites, instrumented buoys, and balloons generated a torrent of unprecedented weather data from vast ocean areas of the Tropics and Southern Hemisphere--areas where conditions profoundly affect world weather, but which have been virtually unobserved.

The new information will fill great gaps in the overall world weather picture and become part of the most complete global meteorological record ever assembled. With this 12-mo record, scientists will try to gauge the practical limits of weather forecasting and design a world weather observing system to achieve these limits.

During the first intensive observing period, January 15 to February 20, 1979, U.S. Air Force and NOAA aircraft operating from Hawaii, Panama, Diego Garcia in the Indian Ocean, and Ascension Island in the South Atlantic flew 171 sorties and launched 2,813 windsondes. These parachute-borne instrument packages, dropped at 217-mi intervals from as high as 42,000 ft, provided data on winds, temperature, humidity, and pressure.

The greatest amount of new information came from the tropical eastern and western Pacific, where Air Force C-141 jets flew 101 sorties and launched 1,740 windsondes. Sixty-three sorties were flown from Diego Garcia and 818 windsondes were dropped. In the South Atlantic operations were sharply curtailed because of the unavailability of aircraft, and only 11 flights were completed and 205 windsondes launched. Scientists hope to gather needed data in this area during the second intensive observing period, May 10 through June 8, 1979.

U.S. scientists from the National Center for Atmospheric Research (NCAR) released 153 constant-level balloons from Ascension Island in the Atlantic and Canton Island in the central Pacific. The balloons, which float at about 46,000 ft, were used to monitor high-level winds in a 60-degree-latitude belt from 20°N to 40°S. Transmissions from the balloons were relayed by the polar-orbiting TIROS-N satellite to scientists in Toulouse, France, who calculated the real-time wind data. At one time 83 balloons were operating, and 56 were still transmitting near the end of the observing period. As an example of wind coverage, these 56 balloons provided 83 wind vectors in a 24-hr period. Delayed time analysis and quality control procedures will be applied to the data at NCAR.

Other tropical wind, temperature, and humidity readings came from an armada of some 40 oceanographic vessels from 13 nations. The ships were ranged across equatorial areas of the Indian, Pacific, and Atlantic Oceans. Technicians aboard the vessels sent up balloons--usually twice daily--which carried instrument packages. As the balloons ascended to 90,000 ft, windspeeds and directions were precisely computed by a global navigation system called "Omega Navaid." Statistics on the number of launches are incomplete, since the readings were recorded aboard ship and not forwarded to processing centers until the ships reach port.

For the first time, large volumes of meteorological data are coming from the empty expanses of Southern Hemisphere oceans. Prior to the first observing period ships from 14 countries deployed 193 instrumented drifting buoys approximately 621 mi apart in a broad belt from 20° to 65°S. The 165 buoys which are operating have been transmitting sea-surface temperatures and pressure readings which are picked up and later retransmitted by TIROS-N satellite. These surface readings are providing "anchoring" points for space soundings from TIROS-N, thus adding a high degree of precision to the satellite data.

The constant-level balloons and the ship- and aircraft-launched windsondes will operate only during the two intensive observing periods. Other systems will continue to generate data throughout the year-long experiment. All of this additional information will augment the nearly 40,000 observations produced daily by the existing World Weather Watch.

From December 1978 through February 1979, the winter phase of the monsoon experiment (WOMONEX) was undertaken as a regional part of the Global Weather Experiment. Field operations were coordinated from Kuala Lumpur, Malaysia. Twelve nations, including the United States, Peoples' Republic of China, and the U.S.S.R., sought to better understand the nature of monsoons, which provide most of Southeast Asia's rainfall.

The oceanographic program during the Global Weather Experiment is proceeding as planned and includes not only ship-based measurements but also the longer-term deployment of remote instrumentation such as bottom-moored buoys with sensors extending upward through the water columns, bottom-mounted sensors, and free-floating drogued surface buoys. In addition to the drifting buoys in the Southern Hemisphere, 6 buoys have been deployed in the equatorial belt as part of the oceanographic program, and 20 buoys have been deployed in the Arctic Ocean as part of the Polar Experiment.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

MARINE WEATHER REVIEW

The Smooth Log (complete with cyclone tracks, climatological data from U.S. Ocean Buoys, and gale and wave tables) is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The Rough Log is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both Smooth and Rough Logs, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

November and December 1978

SMOOTH LOG, NOVEMBER 1978--The storm tracks this month were fewer than normal and widely dispersed. There was no favorite path. The tracks were spread from 75°N over the Greenland Sea to 25°N off the coast of the United States to 20°N off the West Indies. Climatology shows primary tracks across the Great Lakes and Maritime Provinces and into the Labrador Sea, and from off the east coast of the United States to across Iceland and into the northern seas.

The monthly mean sea-level pressure was also quite different from climatology, especially in central pressures. The Icelandic Low had its principal center at 991 mb near the climatic position at 62°N, 30°W, but it was 12 mb deeper. There were two secondary Lows stretching northeastward--a 993-mb center between Norway and Spitsbergen and a 994-mb center over Nova Zemlya. This produced a large negative anomaly area over the polar region. There was a minus 13-mb area south of the Denmark Strait and a minus 17-mb area over the Kara Sea.

The Azores High, which is normally 1019 mb near 35°N, 30°W, was completely overshadowed by a 1030-mb center over Hungary. The pressure over the eastern United States was also higher than normal. This higher pressure resulted in positive anomalies over most of the Northern Hemisphere middle latitudes. A large plus 14-mb area was over western Europe. This positive area stretched from the Shetland Islands south across the Sahara Desert. A positive anomaly area stretched from a 4-mb center over New England to a 12-mb center west of Vancouver Island.

The upper air pattern and wind flow at 700 mb differed mainly in central heights. The Low over Baffin Island was 122 m deeper than the climatic normal. Across the midlatitudes the pressure surface ranged from 60 m higher over Virginia to 117 m higher over Germany. Over the North Atlantic the winds were mainly zonal with no sharp trough. It would be difficult to precisely locate the long-wave trough.

There were no tropical cyclones this month. For the season there was a total of 11 tropical cyclones, six tropical storms -- Amelia, Bess, Debra, Hope, Irma, and Juliet -- and five hurricanes -- Cora, Ella, Flossie, Greta, and Kendra. This was the largest total number of tropical cyclones since 1971. The annual average for the past 30 yr is four tropical storms and six hurricanes for a total of 10. The annual article describing the tropical cyclones of 1978 is in the March 1979 issue.

Extratropical Cyclones--This was a strong storm as it moved across the Northwest Territories of Canada laying down a blanket of snow. Late on the 2d it crossed over the Labrador Sea and picked up additional moisture. At 1200 on the 3d, the 980-mb LOW was near 56°N, 47°W. A Soviet ship 400 mi south of the center fought 56-kn winds and 20-ft seas. The KURDISTAN (59°N, 28°W) reported only 40-kn winds, but the swell waves had built to 26 ft with the long fetch. On the 4th the LOW was traveling northeastward over Iceland and bringing gale-force winds to ships in the Norwegian Sea. On the 6th it died over the Greenland Sea.

As the storm above turned toward Iceland, a frontal wave developed near 50°N. The circulation exploded and within 12 hr it was 984 mb near 48°N, 29°W. A U.S. Navy ship was west of the center with 60-kn northeasterly winds and 31-ft waves. The CETRA CARINA was east of the front with 50-kn winds out of the south in squalls. The SUGAR TRANSPORTER was fighting 23-ft waves and 30-ft swells near 46°N, 41°W. On the 5th the GXXZ had 60-kn easterly winds with 25-ft waves slightly north of the storm's center. Ocean Weather Station Romeo was holding on station with 23-ft waves. On the 6th the POLYARNYY KRUG (59°N, 24°W) had 33-ft swells pounding her starboard quarter.

A strong storm moved across northern Hudson Bay on the 3d, but it broke up on the Greenland Icecap on the 5th. Another center formed near Kap Farvel late that day. Late on the 6th and early on the 7th, the PAULA HOWALDT RUSS was near 57°N, 40°W, with 50-kn winds and 23-ft seas. To the south OWS Charlie was contending with 21-ft swells. At 1800 the C.P. VOYAGEUR and the RIGG were south and west of Ireland with waves running 25 to 30 ft and winds blowing up to 53 kn. Twelve hours later the RIGG's radio report indicated 36-ft swells. This LOW became stationary over northwestern Iceland on the 7th and disappeared on the 8th.

At this time another LOW moved across the Labrador Sea. It also vanished over the Icecap with another LOW forming east of Kap Farvel. At 1200 on the 8th, the INDIGUIRKA near 59°N, 39°W, reported westerly winds of 47 kn with seas of 26 ft.

A high-pressure center had been holding firm over the Balkans and the gradient over the North and Nor-

wegian Seas tightened. The weather station at Molde, Norway, on the coast, measured 50-kn winds on the 9th. A SHIP at 60°N, 34°W, was sailing westward into 44-kn winds, 20-ft seas, and 30-ft swells. The RO near Nordkapp was battling 49-kn winds and 26-ft seas. On the 10th this LOW also disappeared.

This storm began in the vicinity of Reindeer Lake in central Canada. The LOW was tracking across lower Hudson Bay. Late on the 8th at 2200 the ROBERT C. STANLEY on eastern Lake Superior measured 56-kn southerly winds east of the cold front. Two hours later at 0000 on the 9th, the MIDDLETOWN on upper Lake Michigan struggled with strong gales of 42 kn and waves of 14 ft. The LOW crossed into the Labrador Sea near Cape Chidley, and the front swept southward over the Lakes with winds of over 40 kn. As previous storms had done, it dissipated over the Greenland Icecap, and a new center formed east of Kap Farvel. A SHIP near 55°N, 40°W, had 44-kn gales accompanied by 16-ft seas just prior to passage of the front on the 10th. The BRUARFOSS (58°N, 44°W) was west of the front with 40-kn winds and 30-ft seas. At 1200 on the 11th, the 974-mb storm was over the Denmark Strait. OWS Lima measured 40-kn gales with 20-ft seas, and Mike had 43 kn with 21 ft. The OGDEN FRASER was crashing into 30-ft swells.

On the 12th the LOW retrograded southwestward, and the winds and seas to the south began to increase. Charlie had 23-ft seas and 26-ft swells with 45-kn winds. A Soviet ship was near 70°N, 15°E, with 43-kn southwesterly winds and 28-ft waves. The RO was in the same vicinity (71°N, 19°E) and reported 39-ft waves. There were many reports in the North and Norwegian Seas of 40- to 50-kn winds and waves to 25 ft. On the 13th and 14th the RIGG measured winds over 50 kn and waves over 34 ft. OWS Lima measured 60-kn winds on the 14th, but did not venture out to see the waves. At this time another center had broken off and moved northeastward, and yet another center was moving across the southern periphery. Gales, rain, and floods hit many areas of the United Kingdom and Eire. Extremely high waves hit the east Kent coast.

This storm came out of the desert area of the Southwest and passed north of Lake Superior on the 14th. Five vessels on the Great Lakes filed wind reports of over 40 kn with waves up to 10 ft. Late on the 13th (1800) the JOHN DKYSTRA measured 44-kn winds over central Lake Superior. At the same time on the 14th the HEBERT C. JACKSON measured 50-kn winds out of the west on upper Lake Huron. The storm continued eastward and passed south of Kap Farvel on the 16th. It continued to near Iceland, where it deteriorated. In the open ocean it was not a serious threat to shipping according to the weather reports. Ocean Weather Station Charlie appeared to be the hardest hit with 40-kn winds and 24-ft seas.

This storm came out of the Midwest storm factory and took the Great Circle track toward Iceland. This took the storm over the Great Lakes on the 17th and 18th. On the afternoon of the 17th gale warnings were posted for Lakes Michigan, Huron, and Ontario. Later in the evening storm warnings were issued for Lake Huron and parts of Lake Michigan. Gale warnings were expanded to include the remainder of the Lakes. Winds of over 35 kn produced high-water levels and 10-ft waves over eastern Lake Erie. On the morning of the 18th, storm warnings were placed over Lakes Huron and Erie. Flooding and erosion warnings were in effect for the New York shore of Lake Erie. There were eight reports of winds over 41 kn. The highest was 48 kn reported by the JOHN G. MUNSON on lower Lake Michigan with 12-ft waves. The ARTHUR M. ANDERSON measured 45-kn winds and 15-ft waves in the same area. The sidewheeler MARK TWAIN was blown over and sank in the shallow waters of western Lake St. Clair. As the storm approached the coast it brought 40-kn southerly winds to the Bay of Fundy on the 18th. On the 19th a ship found 60-kn winds near 44°N, 60°W, the LINDIN had 57-kn winds near 67°N, 25°W, and the C. P. VOYAGEUR (44°N, 39°W) had 46-kn southerly winds with 39-ft swells. On the 20th OWS Charlie registered 28-ft seas, while Lima was fighting 21-ft seas with gales in the 40's.

The 972-mb LOW skirted the southern Icelandic coast on the 21st. The SVENDBORG near 60°N, 20°W, was battling 60-kn winds from the west; while the IRAFOSS had only 44 kn, but the swell waves were 33 ft at her 60°N, 03°W, location. There were many 40- to 45-kn wind reports in the vicinity of 60°N and the Greenwich meridian. The highest waves were 21 ft. On the 22d the CITY OF ST. ALBANS found 60-kn winds near 53°N, 05°W. The MATCO AVON and another British ship were battered by 30-ft seas near 60°N, 02°E. By the 23d the LOW was north of Nordkapp and heading toward Spitsbergen. Another LOW had formed southwest of Iceland keeping some gale winds over the major shipping lanes.

As a LOW over Ontario with a front paralleling the Appalachian Mountains moved eastward, another LOW formed east of Long Island on the 24th. On the 25th the LOW was 978 mb near 41°N, 56°W. The JUPITER near 43°N, 43°W, in the southerly flow had 55-kn winds driving 20-ft seas and 26-ft swells. The BIRKENHAIN had 50-kn winds south of the center. The FRITHJOF (60°N, 49°W) north of the rapidly intensifying storm fought 60-kn easterly winds with 33-ft seas. At 1200 on the 26th the storm was 966 mb near Belle Isle. A small LOW had developed south of Iceland. Except for it, this deep storm and a 1043-mb HIGH near 42°N, 20°W, were the only circulations over the ocean from 65°N to 20°N. Ocean Weather Station Charlie had 23-ft swells and Lima had 28-ft seas and swells. The RED JACKET (43°N, 38°W) had 50-kn southerly winds and 17-ft waves.

The 970-mb LOW was moving northward over the Labrador Sea on the 27th. Except for the HIGH off of Portugal, its flow dominated the North Atlantic. The FRITHJOF was still near Kap Farvel at 59°N, 46°W, with 60-kn winds and 36-ft seas. Several other ships radioed winds over 50 kn and seas near 30 ft. As the LOW tracked toward the Davis Strait, another LOW formed east of Kap Farvel on the 28th. Two ships reported 55-kn winds in the 40°N latitudes along 25°W and the front. Another had 30-ft swells. On the 29th the Soviet ship ERET reported 78-kn westerly winds with 30-ft swells.

The LOW off Kap Farvel remained quasi-stationary until the 30th, when another deep system absorbed it. The original LOW continued northward to the vicinity of Thule, Greenland.

This storm settled over the Mediterranean Sea on the 26th as a frontal wave. The storm center remained nearly stationary near Rome, Italy, through the 29th, drifting slowly southward and eastward. During this time its circulation increased to cover most of western Europe and into the Sahara Desert. There were quite a few thunderstorms, and on the 28th Marseille measured 40-kn northerly mistral winds. The BRITISH HOLLY off the southwest coast of Sardegna had 60-kn westerly winds and 41-ft swell waves. Another ship a few miles to the south had 33-ft waves. On the 29th some of these high winds hit Naples with 40 kn. At the same time a Soviet ship reported 66-kn winds and 25-ft seas south of Menorca. The BRITISH HOLLY was now near Menorca with 39-ft waves. The BENCRUACHAN in the same vicinity had 48-kn winds and 30-ft seas. Winds up to 50 kn and high waves continued over the western sea into the 30th. At this time a LOW was moving eastward and weakening from its minimum of 985 mb at 0000 on the 29th. The winds slackened as the northwesterly circulation moved over the western sea. On December 1, the storm stalled over the Black Sea.

This incipient storm formed as a frontal wave on a weak warm front off Atlantic City, N.J., on the 28th. This should have been foreboding as it is not common for a frontal wave to generate on a warm front. The CONNECTICUT (38°N, 65°W) had 40-kn gales as the storm moved south of Newfoundland on the 29th. By 1200 that day the storm was 978 mb near 49°N, 48°W. The ASIA FREIGHTER was south of St. Pierre with 55-kn winds and seas of code figure 30--49 ft.

At 1200 on the 30th, the storm had plunged to 956 mb near 55°N, 35°W. Several ships had winds over 60 kn. They included the AMERICAN ACCORD, ATLANTIC COGNAC, another French ship, and a Finish ship. The ACCORD plunged into 40-ft seas and the COGNAC had 33 ft. The 1500 report from OWS Charlie listed wave code 41--67 ft! Two later reports listed 39- and 41-ft waves. Wave reports over 30 ft continued into December 1. The winds were generally in the 40- to 50-kn range. The storm was moving northward on the 1st and died over Kap Farvel on the 2d.

This storm originated near Atlanta, Ga., late on the 29th. It raced up the East Coast and by December 1 was south of St. John's. It almost deteriorated to a trough, but by 0000 on the 2d it suddenly gained new life. A French ship found 40-kn winds and 20-ft seas east of the front. The AMERICAN LEGACY was near 46°N, 34°W, with 45-kn gales and 15-ft seas. Her barograph had dipped to 973 mb. At 0600 the storm's center passed almost directly over the HENRI POINCARE (46°N, 26°W). She reported a pressure of 973 mb. 90-kn southwesterly winds, 29-ft seas, and 36-ft swells. Later at 2100 OWS Romeo measured 50-kn winds and 33-ft seas. Three hours later the seas were 36 ft. The storm was traveling northward off the coast of Ireland, bringing 40- to 50-kn winds on both sides of the United Kingdom. Late on the 4th it dissipated in response to another intense storm moving eastward.

Casualties--The ferryboat AMERICAN LEGION struck a concrete bulkhead during thick fog early on the 7th. The 21,000-ton vessel was going 10 kn at the time it struck. Some 240 passengers were injured. The 999-ton HAWTHORNE ENTERPRISE developed a list in heavy weather on the 6th south of Jamaica. The crew abandoned ship on the 7th and was rescued by the REUBENS. The abandoned vessel was lost from radar during a heavy rainstorm. The 24,698-ton Greek bulkcarrier IRENE S. LEMOS and the 19,724-ton Panamanian bulkcarrier MARITIME JUSTICE collided in fog in the Mississippi River early on the 9th. The LEMOS sank and the JUSTICE went aground. The Greek freighter BLUE MED (5,218 tons) arrived Cartagena with severe weather damage. The 1,412-ton ANNEMIEKE sank off northeastern Scotland after taking water during heavy weather. The crew was rescued.

The 852-ton French ISOLE was loading at Paspebiac, Quebec, and ordered to sail due to high winds. On departure the vessel was battered against the dock and sustained damage to the hull. During a heavy snowstorm on November 26, two barges were involved in heavy weather and grounded at East Chicago.

It was reported on the 30th that the Canadian icebreaker JOHN A. MACDONALD (6,186 tons) struck heavy ice between the 13th and 19th while operating near Booth Island. The forward starboard deep tank was flooded. The vessel will proceed to drydock for permanent repairs at ice breakup in 1979.

On the night of the 28th the 5,813-ton Brazilian cargo vessel LLOYDBRAS came in contact with the 12,808-ton Liberian bulkcarrier FEDDY at Genoa Roads during strong winds.

SMOOTH LOG, DECEMBER 1978--December was a rough month for shipping on the North Atlantic. There was a major departure from climatology in the storm tracks once they passed off the North American west coast between latitudes 40° and 50°N. Climatology indicates two primary paths over water, one northward into the Labrador Sea and the other northeastward over Iceland. This month the primary path moved eastward from Nova Scotia to the United Kingdom. There was a secondary path from off the Carolinas to the Iberian Peninsula. There was also a secondary path that branched off the primary path south of Iceland and moved northward. Several storms turned westward north of latitude 55°N. One of these traveled westward from 25° to 55°W. Three cyclone centers tracked across the Mediterranean Sea.

The mean sea-level-pressure pattern reflected the storm tracks. It also differed widely from climatology. The Icelandic Low at 990 mb was many miles southeast of its 1000-mb climatic position. Normally, it is near 61°N, 30°W. This month it was near 53°N, 22°W. This also resulted in the Azores High being about 10° latitude south of its normal position. The normal High over the Greenland icecap was 5 mb higher than usual and off the east coast. There was also an anomalous 1021-mb High over the Gulf of Bothnia.

There were two large primary anomaly centers. The one that affected the primary shipping lanes was minus 21 mb near 49°N, 20°W. The other was plus 15 mb near Jan Mayen Island. The zero isoline approximately paralleled latitude 60°N between Greenland and Scotland.

The upper air pattern at 700 mb was completely zonal from coast to coast between 30° and 50°N. There were three low centers between 50° and 60°N spread

from Hudson Bay to south of Iceland. There was a completely anomalous closed High over the east coast of Greenland at 70°N. The long-wave trough normally over the U.S. East Coast was over the Plains States. The usual slight ridge west of Europe did not exist. The locations of the anomaly center closely matched those at sea level.

Extratropical Cyclones--This first storm had its genesis over Ontario on the 2d out of a shallow trough. On the 3d the storm moved over Cape Race, and several ships including the DART AMERICA found 50-kn winds south of Cabot Strait. By 1200 on the 4th, the 954-mb malestrom was at 53°N, 39°W. OWS Charlie had 60-kn winds and 23-ft waves. The SUGAR REFINER also found 60-kn winds with 30-ft waves near 50°N, 43°W. Many ships had winds in the 45- to 50-kn range with at least three reporting 33-ft swell waves. On the 5th and 6th, the LOW stalled near 54°N, 38°W. The SEA-LAND PRODUCER was south of Lands End on the edge of the storm on the 5th with 65-kn southerly winds. Winds of 40 to 50 kn and waves of 20 to 30 ft continued through the 6th. Early on the 7th the LOW dissipated as the next one described became the primary circulation center.

This vicious LOW formed as a frontal wave south of the above-described LOW on the 6th. It turned northward late that day to eventually turn westward and end over the Labrador Sea. The LONDON VISCOUNT at 43°N, 24°W, was in the warm sector with westerly 55-kn winds and 25-ft waves. The ARCTIC TROLL was southeast of the cold front (41°N, 30°W) and pounded by 60-kn winds and 33-ft swells. On the 7th the DART ATLANTIC (45°N, 30°W) had 60-kn winds and 36-ft waves. Six hours earlier they had been 41 ft.

By 1200 this was the single LOW that dominated the ocean from shore to shore and from 30° to 70°N. The central pressure was 946 mb. There were over half a dozen reports of 50-kn winds and above in the southwest quadrant. The highest reported was 64 kn by the LONDON VISCOUNT. This ship and the SHACKLETON (42°N, 23°W) both reported 41-ft swell waves. The EXPORT LEADER was not far from OWS Romeo. At 1200 she reported swell waves of 57 ft, and at 1800 she reported 49 ft. Romeo had 33-ft waves at the time.

On the 8th the higher winds had shifted to east of the center over the North and Norwegian Seas. Waves up to 25 ft were still occurring south of the storm's latitude. At this time the storm began a westward trek. The central pressure was slowly rising.

Troughs and frontal waves were moving around the southern circulation. This led to a band of tight gradient between 35° and 40°N latitude. The waves were running about 20 ft. One of these frontal waves developed into the next described storm. The original LOW finally disappeared over the Labrador Sea on the 11th.

Monster of the Month--This storm was first analyzed on the 0600 chart of the 10th. At 1200 it was 960 mb near 46°N, 21°W. The ROBERTS BANK (40°N, 22°W) was devastated by 78-kn southwesterly winds and 41-ft swell waves. The ATLANTIC CAUSEWAY (44°N, 28°W) had 60-kn winds out of the west. At 0000 on the 11th, the storm was 952 mb near 46°N, 20°W. The ROBERTS BANK had sailed only about 20 mi in 12 hr

and now had 65-kn winds from 290°, 20-ft seas, and 46-ft swells from 270°. The SHACKLETON was closer to the center with 55-kn winds and 41-ft seas. Some of the highest wave reports during the day were 49 ft by the CITY OF LONDON (43°N, 10°W), 49 ft by the HOEGH MERCHANT (42°N, 16°W), and 52 ft by the HALIFAX STAR (46°N, 08°W).

The storm turned westward late on the 11th as the next severe LOW moved south of the center. It was difficult to distinguish which storm the high winds and waves were associated with, but to the ships involved it really did not matter. This second LOW had formed over Maryland as a frontal wave on the 9th. It raced eastward and deepened rapidly. On the 10th the HECTOR (37°N, 69°W) was sailing into 50-kn winds, 28-ft seas, and 39-ft swells. The 7,520-ton ELDANIA radioed a distress call at 0645 on the 11th from near Anticosti Island because of the storm and engine trouble. An hour later she was able to anchor and cancelled the distress call. At 1200 on the 11th the LOW was 964 mb near 51°N, 35°W. The AMERICAN ARROW and the BRONISLAW LACHOWICZ in the vicinity of 44°N, 44°W, both had 60-kn winds and waves near 30 ft. The EXPORT LEADER (46°N, 41°W) had the greatest problem with 66-ft swell waves with only 50-kn winds.

On the 12th the first center was 948 mb and the second 954 mb. There was one giant cyclonic circulation that stretched from Nova Scotia to western Russia. There were so many wind reports of over 50 kn and wave reports over 30 ft that it is impractical to list them. The AMERICAN ARROW had the highest of 89-kn winds with 52-ft seas. On the other side of the ocean OWS Romeo fought to stay afloat in 43-ft seas. The CRANIA (43°N, 25°W) had 46-ft waves.

The 37,000-ton West German barge carrier MUNCHEN radioed a distress call at 0325 on the 12th near 46.2°N, 27.5°W. The weather was so bad that several ships passing through the area could not turn to search. Aircraft joined the search to no avail. Liferafts from the vessel were found, but there was no further trace of the vessel or crew. The search was discontinued on the 20th. Also on the 12th at 2209 the salvage tug RODE ZEE reported that the 16,190-ton ORE PRINCE was disabled and drifting about 150 mi southwest of Brest. The tow had parted in the severe weather. Eight fishermen were presumed lost in the sinking of a French trawler off the southwest coast of Britain. The 3,285-ton cargo vessel PLAYAS reported heavy weather damage. The Greek freighter SYROS (5,643 tons) broke her mooring in high winds in Leixoes harbor in Portugal and collided with another vessel.

Figure 61.--The last of six crewmembers is winched across rocks to safety 7 hr after the freighter TORBAY ran aground in rough seas near Oporto Harbor. Wide World Photo.

A large floating drydock broke tow from the Dutch tug TYPHOON and ran aground on the 13th near Pointe De Penmarch in the Bay of Biscay. The German cargo vessel ANTARES requested survey of heavy weather damage which occurred from the 11th to the 19th enroute from Nova Scotia to Dunkirk.

Torrential rains and gales up to 100 mi/h on the night of the 12th killed three British motorists, uprooted trees, and damaged property. The 8,109-ton REGAL SEA reported a man lost overboard off the coast of Brittany.

The gradient started relaxing on the 13th as the second LOW stalled north of Ireland. The maximum winds were in the 50-kn range, but high seas and swell waves persisted. Romeo took the prize with 49-ft seas. The META at 48°N, 06°W, came in second with 48-ft waves. Waves up to 36 ft continued through the 14th. By 1200 the first LOW had dissipated, but this did not improve the situation enough to prevent the Panamanian freighter TORBAY (fig. 61) from running aground near Oporto Harbor in north Portugal. The second LOW continued to slowly move southeastward into Belgium to finally deteriorate north of the Black Sea on the 17th.

This storm came out of south-central Canada near Lake Winnipeg. As the center moved north of the Great Lakes, several ships found strong winds. The HERBERT C. JACKSON measured 50-kn winds, and the G.M. HUMPHREY had 42-kn winds and 13-ft seas on Lake Huron. As the southern circulation moved over the Gulf Stream on the 17th, it began to intensify. That evening Boston, Mass., measured gusts to 60 mi/h, Worcester had 62 mi/h, and Wallops Island, Va., had 47 mi/h. At Mount Washington Observatory in New Hampshire (6,262 ft) the winds blew at 128 mi/h, increasing to 132 mi/h on the 18th. The average speed was 90 mi/h. The POST CHARGER was off Cape Cod early on the 18th and radioed a wind report of 72 kn. The NANT near 40°N, 69°W, reported winds of about 45 kn and seas building to 28 ft. The ROBERTS BANK was near the U.S. coast and again was slammed by 39-ft swell waves about the time that she encountered the cold front. Later the LASH ITALIA (35°N, 57°W) had 58-kn winds. Boston had 58 mi/h gusts with prevailing winds of 30 to 40 mi/h over southern New England. On the 19th the NANT found 26-ft seas near 40°N, 70°W, and the BARON BELHAVEN, sailing southwestward off the coast, was slapped by 33-ft swells.

The storm passed over Belle Isle on the 20th and tracked toward the Labrador Sea. This was one of two storms that traveled this primary climatological storm track this month. The STONEPOOL (37°N, 56°W) was far south of the LOW with 50-kn winds, 23-ft seas, and 36-ft swells. The ADM. WM M CALLAGHAN was farther east near 35°N, 51°W, with 40-kn winds and 25-ft waves. At midday on the 21st OWS Charlie was in the tight gradient between the front and a HIGH over Iceland with 40-kn winds and 21-ft seas. On the 22d the LOW was over Foxe Basin headed north into the Arctic Ocean.

This storm came off the eastern slopes of the Rocky Mountains. It was over Ottawa, Canada, on the 21st. Its circulation was influencing shipping off the North American east coast. A ship with the call letters LF3Q reported 56-kn southeasterly winds off Nova

Scotia. On the 22d another ship reported winds over 50 kn and swell waves of 30 ft near 40°N, 56°W, in the warm sector. Behind the cold front a SHIP had 50-kn winds with no seas reported. On the 23d and 24th the LOW stalled near 53°N, 52°W. There were gale reports in the westerly winds that connected this LOW with another off the English Channel. The EXPORT PATRIOT (45°N, 16°W) was in the circulation of this second LOW with 55-kn westerly winds and 41-ft seas. It dissipated as the next LOW developed over midocean.

This storm started as a frontal wave on the 23d in the circulation connecting the two LOWs mentioned above. It moved north-northeastward until turning westward on the 24th. By 1200 it was becoming the primary circulation and the NORTHERNSHELL had 56-kn winds near 46°N, 58°W. OWS Lima was in the easterly circulation north of the centers with winds of 47 kn and 23-ft seas. On the 25th it became the primary LOW at 980 mb near 52°N, 28°W. OWS Lima now had 50-kn winds and 30-ft seas. There were 40- to 50-kn easterly winds over the North Sea. Lima now had 50 kn and 30-ft seas. At 1200 the AMERICAN ARROW found 58-kn winds near 42°N, 41°W. The BELLA COOLA near 40°N, 44°W, verified this with a 56-kn report with 36-ft seas added. OWS Romeo was fighting 23-ft seas. Twelve seamen were rescued in the North Sea from the 2,285-ton Swedish freighter ALSTERN. The crew spent 5 hr in liferafts off the east coast of Scotland. The gales also forced a British coaster aground with a crew of eight.

The storm was traveling southwestward on the 26th, while another low-pressure center had formed to the south. This center was to become the storm to contend with on the 27th. At 1200 on the 26th a ship near 38°N, 26°W, had 55-kn northwesterly winds. Thirty-three foot waves pounded the WELCH CITY about 4° latitude to the north. OWS Romeo had 23-ft seas on the 27th, while Lima had 20-ft seas. The POSEIDON (60°N, 18°W) was tossed about by 26-ft seas from the east. These reached Lima on the 28th. This storm disappeared as another approached.

This storm was of Creole origin. It quickly moved over the Atlantic Coast States and passed near Cape Cod on Christmas Day. On the 24th and the 25th Wallops Island measured winds over 50 mi/h. The Mount Washington Observatory had 66 mi/h winds and gusts to 149 mi/h on the 25th. Gusts remained over 100 mi/h through the 27th. Providence, R.I., recorded windspeeds up to 50 mi/h. The ARCO PRESTIGE and EXXON JAMESTOWN were both near 39°N, 72°W, with waves to 30 ft. The former reported 45-kn winds, and the latter had 60-kn winds from the west. At 0000 on the 26th the storm was 980 mb near Portland, Maine. The AMERICAN ARCHER (43°N, 65°W) experienced 55-kn winds driving 30-ft seas. The storm relaxed as it moved south of the Maritime Provinces, but it regained its strength later. At 1800 on the 27th, the 970-mb storm was near 47°N, 33°W. The DALESMAN at 40°N, 38°W, was ravaged by 55-kn winds from 290°, 33-ft seas, and 49-ft swells. The EXPORT PATRIOT (40°N, 39°W) found the same winds, but the seas were 44 ft and the swells 33 ft. It was definitely not a pleasure cruise.

On the 28th the winds were generally in the strong gale category. The MINERAL HOBOKEN found 33-ft swells near 43°N, 23°W. Lima measured 50-kn winds and 30-ft seas. The LOW crossed over the United Kingdom on the 29th bringing a severe snowstorm. A band of snow across Scotland blocked roads and stranded hundreds of travelers. To the south heavy rain caused severe flooding. Hundreds were evacuated at York, when the Ouse River reached 16 ft above its normal level. Gales lashed Ireland and Scotland. At Glasgow a fishing boat sank.

In Sweden snow blocked railroads, and the main northbound highway in the south was blocked when three trucks collided. The Baltic Sea froze over earlier than usual. Gales lashed the Normandy and Brittany coasts of France. In Denmark and the Germanies snow snarled traffic. In southern areas of Europe (the Alps southward), the weather was warm with heavy rain in France. Avalanche warnings were posted in the Alps.

Each storm this month was quickly followed by another. This one formed south of Newfoundland at a developing occlusion. It was first located on the 1800 chart of the 27th. The easterly flow north of the storm centers had maintained itself. A ship near 40°N, 59°W, was sailing into 50-kn winds and 26-ft seas at 0000 on the 28th. Other ships to the east were finding 20- to 25-ft seas. On the 29th the EXPORT FREEDOM near 37°N, 56°W, was plowing into 34-ft swell waves. At 1200 and 1800 the sister ship EXPORT PATRIOT at 42°N, 40°W, was pounded by 50-kn winds and 36-ft seas. The DELTA DRECHT (46°N, 33°W) east of the storm had 50-kn southwesterly winds and 33-ft swells. The storm was 970 mb near 49°N, 33°W, at 0000 on the 30th. At midday the EXPORT PATRIOT had traveled 1° longitude in 24 hr and was still being pounded by 36-ft waves. OWS Charlie had 25 ft. By the 31st another center was analyzed to the west, and this one disappeared by the end of the day.

Casualties--The Liberian-registered BURMAH AGATE with 53,000 tons of crude oil was stranded at Southwest Pass on the Mississippi River. Rough weather delayed lightering and refloating. The Cypriot BARAKAT (1,096 tons) ran aground in heavy weather. She was refloated, but then grounded again by strong winds in Lebanon. The barge ROBERT L. POLING and the AMY MORAN collided in fog on the 9th in Gravesend Bay near Coney Island. The 6,500-ton floating drydock No. 109 broke tow from the tug TYPHOON in heavy weather and grounded on rocks near Pointe de Penmarc'h on the 13th. The British cargo vessel GEEST-TIDE (5,871 tons) reported heavy-weather damage on the 14th on a voyage to Barbados. The Liberian tanker SEA VALIANT (38,529 tons) lost both bower anchors in rough weather in 18 fathoms of water about 4.5 mi off Leixoes. The C.P. VOYAGEUR reported heavy-weather damage upon arrival at Montreal about the 20th. The 500-ton Greek DIMITRIOS ran aground in heavy weather on the 19th near Otranto, Italy. Two ships ran into trouble off Scotland in the North Sea on the 24th. The Swedish ALSTERN sank during heavy weather 150 mi east of Firth of Forth. The 696-ton British FENDYKE was struck by a freak wave off Carnoustie and went aground.

The American barge PECK SLIP with 80,000 barrels of oil ran into rough weather near Puerto Rico.

High waves damaged the deck piping system with loss of oil. The Greek cargo vessel PANAGHIA THEOSKEPASTI (8,228 tons) was anchored at Gibraltar on the 28th with engine trouble. The current carried her into the Mediterranean, and tug assistance was required.

The 1,591-ton Turkish KALKAVANLAR ran aground in rain and fog on the Greek island of Samos on the 27th. On the 28th the 3,300-ton Greek TENORGA sank in stormy seas near Leixoes. Four crew died and 17 were missing. The Spanish UNAI (1,304 tons) dragged anchors in heavy weather off Marina di Carrara and struck a breakwater on the 29th.

The Canadian bulkcarrier ALGORAIL was pushed aground by ice in the Detroit River on the 30th. The 3,528-ton Guatemalan-registered LAGO IZABAL reported heavy-weather damage in the Gulf of Mexico.

The 218,665-ton Greek tanker ANDROS PATRIA with 100,000 tons of crude oil was abandoned on the 31st with fire in one of the holds. Three of the crew were rescued, but 34 were missing in heavy seas. The vessel was 24 mi off Cabo Villano. The holds were breached by the heavy seas. Strong gales were pushing an oil slick toward the Spanish coast. The vessel was taken in tow by tugs, and the remaining oil was offloaded. The 1,600-ton Cypriot DECIMUM did not receive the same publicity as the ANDROS PATRIA, when she sank in the same area (37.5°N, 12.2°W) on the 31st with one crewman dead.

Smooth Log, North Pacific Weather

November and December 1978

SMOOTH LOG, NOVEMBER 1978--The cyclones that traversed the North Pacific this month were fewer than usual, but as is likely, they were large and deep. There are normally three primary tracks: Sakhalin Island into the south-central Bering Sea; east of Tokyo northeastward toward Bristol Bay; and midocean near 45°N into the Gulf of Alaska, with part splitting eastward to Vancouver Island. This month there were two primary "eyeball" average paths. One came from near Tokyo east-northeastward, then turned sharply northward between 170°E and 180° into the Bering Strait. The second path was from midocean into the eastern Gulf of Alaska.

There were some large differences in the monthly mean sea-level pressure chart and climatology. Climatology indicates three Low centers of 1001 to 1002 mb stretched across 53°N from the central Gulf of Alaska to north of Adak Island. This month there was one 995-mb center near 55°N, 170°E. The Pacific High was broken into two centers, rather than one elongated east-west ridge. The usual 1020-mb center at 30°N, 140°W, was replaced by a 1026-mb center near 36°N, 138°W. The other center was actually two 1019-mb centers along 29°N at 176°W and 172°E. These conditions set up two large anomaly centers--a minus 8 mb near 56°N, 170°E, and a plus 12 mb near 50°N, 140°W. These centers indicated that approximately north of 30°N and west of 180° the sea-level pressure was lower than normal, and east of 180° the sea-level pressure was higher than normal.

In the upper air at 700 mb a closed-Low center was located over the upper Kamchatka Peninsula instead of the normal trough. This produced a major long-wave trough along 170°E, which is usually over the coast of Asia. There were short-wave troughs over the Asian coast and along 160°W. The usual ridge was present over the North American west coast.

The western ocean produced tropical storms Tess and Winnie and typhoon Viola.

Extratropical Cyclones--This storm formed east of the upper Kamchatka Peninsula on the 2d. This peninsula often influences storms much like southern Greenland and Kap Farvel influence storms in the Atlantic. Old storms will move over the Sea of Okhotsk and degenerate with a new LOW forming east of the peninsula. This is what happened in this case.

A large HIGH was over the central ocean, and the gradient was tighter east of the front than to the west of it. On the 3d and 4th several ships found 40-kn gales and seas to 20 ft. On the 0000 chart of the 4th, Saint Paul Island recorded 50-kn winds. As the storm was passing through the Bering Strait, a frontal wave was rushing northeastward south of the Aleutians. The PORTLAND had 40-kn winds and 16-ft seas over the Gulf of Alaska. On the 5th the USCGC NORTHWIND had 40-kn winds and 21-ft seas within a few miles of OWS Papa, who measured 43 kn and 16 ft. South of Valdez the EXXON NEW ORLEANS found 55-kn winds and 30-ft waves. On the 6th the ARCO FAIRBANKS had 50-kn winds near Middleton Island. The original LOW had now dissipated, and the frontal wave became the primary LOW. It stalled on the coast and also dissipated.

A front stretched southwestward between two large HIGHs from Seattle to Hawaii. On the 4th a wave formed north of the Islands. The MARITIME RELIANCE (34°N, 154°W) was west of the front and well north of the LOW with 50-kn northeasterly winds, 26-ft seas, and 20-ft swells. The SEATRAIN BUNKER HILL was about 90 mi away with 25-ft swells. Other ships southeast and southwest of the center were reporting 20-ft waves. The EASTERN SAGA found 30-ft swell waves at 1200 in the same general area. The storm moved northwestward until the 6th, when it suddenly turned eastward and then meandered between 30° and 35°N straddling 155°W prior to turning northward on the 10th. There were occasional gale reports with waves up to 23 ft at times. The SEA-LAND EXCHANGE at 38°N, 156°W, about 250 mi north of the center had 45-kn winds on the 7th. On the 11th the OCEAN BRAVE near 41°N, 161°W, and north of the storm had 43-kn gales and 28-ft swells.

The storm continued a stairstep track to the northeast and produced only minimal gales and light seas as it crossed onto the Alaska Panhandle on the 15th.

This storm was a continuation of tropical storm Tess who became extratropical on the 7th. The storm passed very nearly over a SHIP near 41°N, 173°E, with 64-kn winds. At 0000 on the 8th the LOW was 972 mb near 48°N, 179°E. The CGC JARVIS was near 54°N, 166°W, and mauled by 87-kn southeasterly winds. The LEO, west of the center, took a similar pounding by 78-kn winds. A SHIP south of the center may have had it worse than the others with 55-kn winds and 34-ft waves. The central pressure continued to drop. As the storm crossed the Aleutians, an island station measured winds over 40 kn on the synoptic time. On the 9th the pressure was 956 mb. The storm now mainly occupied the Bering Sea, and most ships had probably already fled. On the 10th the storm moved over Siberia and collapsed.

A HIGH moved eastward along 45°N and on the 9th was about 600 mi off Seattle. A second cell had formed over Alaska doubling the size of the anticyclonic circulation. A weak LOW was over northwestern Mexico. The pressure gradient was tight from northern California northward. The HAWAIIAN CITIZEN was out of San Francisco with 45-kn winds and 16-ft waves on the 9th and 10th. The ARCO ANCHORAGE was about 120 mi west of the Golden Gate and measured 47-kn winds with 20-ft waves. On the 10th the HIGH moved inland, and a LOW had developed near Las Vegas. This continued the tight gradient off the coast. The ARCO FAIRBANKS measured 50-kn winds and seas of 18 ft. The HIGH continued eastward with the LOW following, and the weather calmed.

A short-lived LOW moved across the Kurile Islands. This storm formed in the sharp trough south of the LOW on the 12th. One of the first observations was by the TOYOTA MARU No. 10 indicating 30-ft swells behind the front.

By 1200 on the 13th, the tremendous LOW was 962 mb near 53°N, 170°E. The ATLANTIC PIONEER found 55-kn winds with 35-ft waves. The PRESIDENT MADISON, far south of the center near 35°N, 165°E, had 55-kn winds and 25-ft waves. There were several ships with 50- to 60-kn winds and high waves. The PESTOVO at 49°N, 179°E, had 36-ft waves. A Japanese ship 600 mi south of the LOW reported 68-kn hurricane-force winds. On the 14th the IRISH PINE, which was 450 mi south, had 30-ft swell waves. The storm passed to the west of the GLADIOLUS, but she was near enough to the 962-mb center to have a 982-mb pressure and 85-kn southeasterly winds. The KANESHIZU MARU (45°N, 165°E) was pounding into 28-ft waves on the 15th. The GLADIOLUS was headed into 58-kn winds. The storm had stalled on the 14th and disappeared on the 16th.

As the LOW moved northward high pressure was moving eastward across the Bering Strait and northern Alaska. Another small LOW was moving into the Gulf of Alaska. On the 15th the HIGH was 1043 mb and the LOW 999 mb. This created a tight pressure gradient along the southern coast. The winds reached 50 mi/h at Anchorage and flights into the airport were diverted or delayed. There was damage to some small aircraft, roofs, and buildings. Peak winds in Valdez reached at least 77 mi/h but damage was minor.

This storm formed in a broad flat gradient over the Sea of Japan on the 14th. The pressure gradient soon tightened and organized. By 1200 on the 16th the 980-mb storm was near 43°N, 163°E. The MAGELLAN MARU, 200 mi southeast of the center, had 28-ft swells from the south. On the 17th the winds were blowing in the 40-kn range. Many of the sea reports were near 20 ft. At 0900 the MAGELLAN MARU now near 41°N, 171°E, reported 43-ft swell waves. Three hours later they had dropped to 33 ft. The SEA-LAND COMMERCE found 36-ft swell waves with only 45-kn winds near 35°N, 168°E. The PACIFIC ACE was nearby at 35°N, 166°E, and measured 42-kn winds from 290°, 20-ft seas, and 51-ft swells. On the 18th the ROKKOHSAN MARU was slightly south of Unimak Pass with 60-kn winds out of the southeast.

As the storm moved northward over the cold Bering Sea, the central pressure started rising. The storm weakened considerably with winds less than gale force.

This LOW was rather short-lived as a vicious storm. The polar front approximated the 30° parallel with frontal waves moving along it. This one became significant on the 15th. On the 16th the PRESIDENT ROOSEVELT (37°N, 168°W) found 60-kn winds and 30-ft waves while about 90 mi south of the 996-mb center. At the same time the HONSHU GLORIA was one degree of longitude to the west (37°N, 169°W) and measured 69-kn northwesterly winds with 25-ft seas and swells.

On the 17th the LOW was moving northeasterly at 986 mb. Three ships radioed observations of 25-ft swell waves in various quadrants. On the 18th the LOW moved against a 1057-mb HIGH centered over Alaska and turned eastward to move ashore on the 20th. Meanwhile, it caught the OCEANOGRAPHER with 43-kn winds.

Monster of the Month--This large storm had many Low centers during its lifetime. Some broke away from the main center, and others were frontal waves imbedded in the large overall cyclonic circulation. A LOW out of Manchuria moved across the Sea of Okhotsk on the 20th and stalled west of the Kamchatka Peninsula. The SINCERE 3 measured 60-kn winds from the south near 50°N, 165°E, on the 20th. On the 23d there was a double center straddling the peninsula, and another center forming to the south near 45°N, 160°E. By the 25th this southern LOW was the primary storm center alined with the primary upper air LOW. On the 24th the VAN CONQUEROR found 40-kn gales. At this time there were five centers in the overall circulation, which stretched from shore to shore. The CHEVRON ARIZONA was

far to the southeast between one of those other centers and the Pacific High (33°N, 152°W) with 45-kn southerly winds. On the 25th the ZENLIN GLORY had 50-kn winds out of the west while west of that center. OWS Papa recorded 64-kn winds from the southeast. The EVER SUMMIT was sailing eastward into measured 52-kn winds and 30-ft waves on the 25th. The waves increased to 31 ft on the 26th, but the winds dropped to 45 kn.

The report from the VAN ENTERPRISE for 0000 on the 26th indicated 99-kn northerly winds near 49°N, 165°E. All the data in the report looked good and fit the analysis, but it appeared that the speed in knots had been doubled owing to the wind indicator showing meters per second. The closest ship with which to compare this speed showed 45 kn. The seas showed only 13 ft and the swells 20 ft. A Japanese ship south of one of the secondary LOWs had 55-kn winds, and the PRESIDENT MCKINLEY had 50 kn near 35°N and the dateline.

On the 27th a SHIP near 37°N, 170°E, found 64-kn winds with 25-ft waves. The ARCO ANCHORAGE at 55°N, 140°W, was east of a secondary LOW with 45-kn winds and 30-ft waves. South of the primary LOW there were 40- to 50-kn winds plotted with waves up to 26 ft.

On the 26th the upper air LOW had split into two centers in the lower levels, and the original primary LOW with its upper air support was moving northeastward toward Nunivak Island. Another surface LOW remained with the other upper air center and began moving east-southeastward. There were four surface centers, but by the 27th they had combined into only two centers.

On the 28th the GREAT LAND and the PRINCE WILLIAM SOUND were south of Prince William Sound with 40-kn westerly winds and 36- and 25-ft waves, respectively. On the 29th the last one of the LOWs was moving toward the Queen Charlotte Islands.

On the 0000 chart of the 27th there was a large 1052-mb HIGH at 45°N, 110°E, over the Gobi Desert. A weaker 1023-mb HIGH was east of Hokkaido. An inverted trough formed between the two HIGHs as the eastern one moved southeastward. A LOW center formed near 31°N, 137°E, in this inverted trough. As the HIGH continued moving southeastward and the Gobi High remained stationary, the LOW moved northeastward and expanded.

On the 28th the TOYOTA MARU No. 11 and the VAN ENTERPRISE in the southeasterly circulation east of the center had 45- and 50-kn winds. The waves were running about 15 ft. The LOW was 989 mb near 44°N, 159°E, at 0000 on the 29th. The SANKOSUN was about 180 mi to the southeast with 45-kn southwesterly winds. The sea waves were reported as 41 ft, and the swell waves were also 41 ft from the south.

The LOW crossed into the Bering Sea near the Rat Islands at 0600 on the 29th. It was 972 mb at 0000 on the 30th. A SHIP north of Adak Island had 50-kn southwesterly winds and waves to 25 ft. On December 1 the pressure had dropped to 956 mb about 300 mi south of the Bering Strait. Two ships about 450 mi south of the center had winds between 40 and 50 kn. They were the ASIA ZEBRA with 30-ft waves and the PINE LIGHT with 39-ft swells. Saint Paul Island had 40-kn bone-chilling winds. On the 4th the storm disappeared north of the Strait.

Tropical Cyclones, Western Pacific--Tropical storm Tess formed west of Guam on the 1st. She moved toward the north-northeast and intensified. The THOMAS WASHINGTON was sailing southward through the storm with 50-kn winds and 30-ft waves. She was a tropical storm by the 3d, and by the 5th winds near her center were roaring at 60 kn as she crossed the 25th parallel near 149°E. Her strength was attested to by a ship which encountered 60-kn northerlies in 20-ft seas and swells at 0600. Moving to the northeast, Tess slowly began to turn extratropical with increasing latitude. However, she was still a potent storm. On the 7th several ships felt her fury. The ZIM GENOVA, some 200 mi to the southeast, reported 45-kn winds. The ZCLD about 100 mi to the south braved 30-ft swells in 62-kn winds, while the OVYZ far to the northeast reported 55-kn winds in 20-ft seas.

Extratropical Tess crossed the Aleutian chain on the night of the 7th and moved slowly northward over the Bering Sea for the next 2 days. Gale- to storm-force southerly winds piled up heavy seas against the northwest Alaska shore. Water went over the sea wall at Nome; it was estimated the sea level rose 10 ft. Surf and large chunks of floating ice battered the waterfront. Several miles of highway were washed away along the Seward Peninsula coastline.

Typhoon Viola popped up just west of Truk on the 17th. She headed west-northwestward. The PIONEER CRUSADER found 45-kn winds and 13-ft seas on the 18th about 150 mi north of the center. It took her 3 days and 900 mi to reach typhoon strength, near 15°N, 135°E. By the 21st winds near Viola's center climbed to 120 kn. The SHINZUI MARU about 240 mi to the west-northwest was battling 43-kn winds amidst 17-ft swells. As Viola crossed the 20th parallel near 128°E, she began to recurve toward the northeast. At the same time her strength began to diminish. However, the ESSO CAMBRIA and the OKEAN both ran into 40-kn winds far to the west of the storm's center. By the 24th the east-northeastward-moving Viola was turning extratropical, but still generating gale-force winds. The MARCONA TRANSPORTER (28°N, 137°E) northeast of the storm was hit by 45-kn winds and giant 46-ft swells. The 1,131-ton Japanese HIMAWARI MARU was missing on the 23d after running into heavy seas from Viola. A search revealed no trace. The 4,009-ton Panamanian GIANT NAVIGATOR sank near 22.7°N, 123.6°E. Sixteen of the crew were rescued and nine were missing.

Three days later tropical storm Winnie sprang up to the southeast of Guam. She headed northward passing about 90 mi east of Saipan on the 28th. Winds reached 55 kn on the 29th, just after Winnie crossed the 20th parallel near 146°E. On the 30th the CHRYSANTEMA and the D5BU both encountered 40-kn plus winds in Winnie's wake as she sped rapidly east-northeastward to become extratropical.

A front from the last-described extratropical storm was being drawn into the circulation of Winnie on the 30th. By 0000 on December 1 she was extratropical at 38°N, 177°E. The storm had passed very near the SANKOSTAR at 1800 on the 30th. At 0000 on the 1st she reported 45-kn winds and 25-ft waves. The LOW was 972 mb near 49°N, 162°W, by 0000 on the 2d. A ship within 60 mi of the center had 52-kn winds and 26-ft

seas and swells. Twelve hours later the central pressure was 960 mb east of Kodiak Island. There should have been many high-wind reports on the 2d, but none came over the radio. On the 3d the LOW crossed the coast and the PORTLAND (57°N, 146°W) was battered by 65-kn winds with 23-ft waves east of Kodiak Island. The GLACIER BAY, 4.5° longitude to the east, had only 45-kn winds, but she was hove to in 33-ft waves. Later at 1200 she had 50-kn winds with no waves reported as she sailed northwestward. By the 4th, the storm had collapsed over the interior.

Casualties--The 59,141-ton British GOTHIA TEAM contacted the lighter PUERTO ACEVEDO in Karachi anchorage in boisterous weather on the 8th.

The barge SEASPAN 191, the end barge in tandem with SEASPAN 190 and towed by SEASPAN WAVE, was found missing in heavy weather on the 18th. The barge was located stranded at Clark Island, Wash., on the 19th and refloated on the 21st.

The 26,681-ton Liberian bulkcarrier PACBARONESS radioed for help on the 21st after her cargo of lumber shifted in heavy weather near 50.3°N, 166.3°E. The OCEAN BEAUTY responded and was standing by. Part of the PACBARONESS' deck cargo was lost overboard. The 3,000-ton Panamanian cargo ship NUSANTARA had a fire aboard while in Manila Bay, where she had sought shelter from typhoon Viola. Nine of the crewmen of the Panamanian freighter GIANT NAVIGATOR (4,009 tons) were missing after the crew of 25 jumped overboard on the 23d. The ship developed a list when its cargo of timber apparently shifted, and it was thought the ship would capsize in the rough seas churned up by typhoon Viola. A Japanese tanker rescued the other 16 crewmen. The 22,452-ton Indian JAGAT NETA requested survey of heavy-weather damage while at Kobe. The DECCAN PIONEER and NORTHERN VICTORY collided in the Eastern Anchorage at Singapore during heavy rain on the 28th.

SMOOTH LOG, DECEMBER 1978--There are normally three primary storm tracks across the North Pacific in December. This month there were two. The westernmost one, which reached from Hokkaido to the eastern shore of Kamchatka, matched climatology. The second track partially matched climatology. It extended from east of Honshu northeastward into the eastern Bering Sea, crossing the Aleutians near 175°E. There were individual storms over the eastern ocean that traveled in all directions with no primary path.

The Aleutian Low was 995 mb near 57°N, 176°E. This compares with a climatology of two LOWs of about 1001 mb, one in the Gulf of Alaska and the other near the Near Islands. The Pacific High was 1025 mb near 41°N, 138°W. The climatic 1020-mb High is near 30°N, 130°W. A climatic 1020-mb High over the Great Basin was 1025 mb.

The most significant anomaly was plus 14 mb centered near 49°N, 140°W. This in part explains the absence of the primary climatological storm track from the central ocean to Vancouver Island. The single Aleutian low center produced a negative 12-mb center near Saint Lawrence Island in the Bering Sea.

The upper air pattern at 700 mb more closely resembled climatology than at the surface. The low center over Siberia was 90 m lower at 2635 m than its climatic counterpart. The main difference in pattern was that the ridge normally over the Rocky Mountains was farther west off the coast.

There were no tropical cyclones this month.

Extratropical Cyclones--When this storm crossed into the Sea of Okhotsk on the 2d, it already had a good circulation. The JUTHLANDIA was west of the Tsugaru Strait with 60-kn westerly winds and 26-ft waves. The SEA FAN was off the eastern shore of Honshu measuring southerly 50-kn winds and 30-ft seas. On the 3d four Japanese ships reported winds of around 50 kn between latitudes 40° and 50°N and longitudes 150° to 170°E. The HONSHU GLORIA was near the Date Line and 45°N with 61-kn winds. The PACIFIC VENTURE had 25-ft waves near 50°N, 167°E. The PRESIDENT JEFFERSON (48°N, 160°E) had 50-kn winds on the 4th. A ship that appeared to be the BRAZILIAN HOPE (51°N, 169°E) was slapped by 30-ft swells. At this time (0000) the LOW was 972 mb near 58°N, 175°E. St. Paul Island had gusts to 69 mi/h. On the 5th the LEO was near the Rat Islands and found 65-kn winds. By the 6th the LOW disappeared over the Arctic ice.

The next storm formed on the western shore of the Sea of Japan. It crossed over Hokkaido on the 5th and by 1200 was a 962-mb maelstrom near 50°N, 157°E. The GLADIOLUS was near 36°N, 145°E, behind the cold front, with 60-kn winds. The PRESIDENT JEFFERSON was now near 45°N, 153°E, with 70-kn hurricane-force winds and 26-ft waves. The ASIA ZEBRA at 48°N, 156°E, was within 100 mi of the center calling the winds 97 kn from 210°. The seas were 30 ft and the swells 46 ft from 180°. The island of Ostrov Urup measured 50-kn winds. The LOW was moving along the Kurile Islands. At 0000 on the 6th the PINE LIGHT was near 47°N, 161°E, nearly due south of the storm's center. She reported 55-kn westerly winds, 23-ft seas, and fantastic 66-ft swells. Her swell code seems high, but all observations appeared good--who can outguess the sea. The closest comparable sea or swell reported was 30 ft. On the 6th and 7th there were several reports of waves over 20 ft, but by 1200 on the 7th the LOW was gone.

This LOW was generated about the same time as the previous one, but nearly an ocean away. It formed on an old polar front north of Necker Island late on the 3d. There were some gale-force winds between it and a HIGH to the northwest. At 0000 on the 5th the 988-mb storm was near 34°N, 160°W. A Korean ship southwest of the storm had 50-kn winds and 20-ft waves, while a ship within 100 mi of the center had 23-ft swells from 130°. At 1200 a ship had 25-ft swells and at 1800 the PRESIDENT VAN BUREN had 50-kn winds.

The storm was moving northward against a 1040-mb HIGH along the West Coast on the 6th. The PRESIDENT MADISON was slightly east of a trough line at 43°N, 155°W, and measured 65-kn winds and 16-ft waves. The VAN BUREN (37°N, 168°W) was contending with 31-ft swells from the northwest. On the 7th the storm crossed the Alaska Peninsula and moved westward.

This LOW broke away from an older one that was moving northward on the west coast of the Kamchatka Peninsula on the 11th. The MAMMOTH FIR was ahead of the storm near 50°N, 173°W, with 50-kn winds and 16-ft waves. By 1200 on the 12th the storm was 966 mb at 56°N, 168°W. There were not many ship reports, but there were a few reports of winds between 40 and 50 kn. The GLADIOLUS was one ship that reported near 48°N, 152°W, with 62-kn winds from the southwest. On the 13th the SHUKO MARU was tossed by 33-ft seas, and the EASTERN FUJI braved 58-kn winds. The EXXON PHILADELPHIA was battered by 60-kn winds and 46-ft swell waves on the 14th near 58°N, 143°W. The 15th found the MOBIL MERIDIAN (57°N, 140°W) with 41-ft swells. The KASUGAI MARU near 50°N, 129°W, contended with 64-kn winds from the northwest, and the ARCO PRUDHOE BAY at 55°N, 136°W, fought 34-ft waves. The LOW became stationary on the 15th and was absorbed by another system on the 16th.

For about a week the ocean was cut up by many LOWs and several HIGHs. None developed very much, so large ships were not threatened. On the 20th the area between 30°N and the Bering Strait supported six LOWs and three HIGHs. That day a LOW developed near 36°N, 152°E. It tracked northeastward, deepening as it moved. By 0000 of the 22d the LOW was 964 mb near 56°N, 177°E. Although the storm was very deep, it was not producing winds much above gale force at this time. Cold Bay, Alaska, measured 52 mi/h winds as did St. Paul Island, where winds gusted to 63 mi/h.

At 0000 on the 23d the KASUGAI MARU found 56-kn westerly winds, 36-ft seas, and 39-ft swells near 54°N, 169°W. The GOLDEN ROD was north of the Aleutians with 49-ft waves and 57-ft swells. Later in the day the storm dominated the area north of latitude 45°N. Several ships in the Gulf of Alaska reported waves near 25 ft on the 24th. The storm was now over the Yukon River where it dissipated rapidly.

Kyushu was the birthplace of this storm on the 22d. The storm moved along the south coast of Japan. The first high winds were reported by fishing boats on the 23d east of Hokkaido. There were three reports near 50 kn with the highest 56 kn. The storm deepened rapidly as it moved over the warm waters east of Japan, and high wind reports increased with larger waves. On the 24th the 9VPV had 60-kn winds near 35°N, 144°E. There were several other reports near 60 kn. The NEDLLOYD FUKUOKA was 5° longitude to the east with 38-ft seas and swells driven by 56-kn winds.

The storm was 972 mb near 43°N, 163°E, early on the 25th. The ALSTER EXPRESS appeared to have found the worst weather. She was at 38°N, 164.5°E, with 60-kn winds from the west-southwest, 33-ft seas, and 49-ft swells. Later information indicated the GOLDEN ROD measured 61-kn northeasterly winds driving 50-ft swells. Other ships were also suffering waves over 30 ft. As usual in the Pacific there are quite a few reports at 0000 but few at the other synoptic hours. The KASUGAI MARU is a very good reporter, and on the 26th her winds were 58 kn with 26-ft waves. The waves increased to 36 ft on the 0600 observation. The SEA-LAND MCLEAN at 37°N, 179°E, was 800 mi south of the center and sailing with 50-kn winds and 33-ft waves on her stern. There was a large area from 300 mi west to 1,000 mi south of the storm's center where nearly all the waves were at least up to 25 ft and many over. Of the five ships that reported under the influence of the storm at 1200, three had waves over 25 ft.

The 0000 chart of the 28th showed a SHIP near 47°N, 174°E, with 39-ft swells. The SEALAND FINANCE was near 42°N, 178°W, at 1200 with 20- to 25-ft waves. A small LOW developed on the periphery of the storm on the 28th, and it became the primary storm late on the 29th.

The Sea of Japan produced this storm. It moved across Hokkaido on the 27th and, as expected, intensified. A ship at 35°N, 147°E, had 50-kn winds from the south and 30-ft swells. Another LOW had developed south of Kyushu on the 27th and was following a parallel track about 600 mi to the south. There were three reports of winds of 50 kn or greater and a 25-ft wave report with this storm.

On the 29th the original LOW absorbed both circulations. The JJAD (36°N, 160°E) fought 50-kn winds, 26-ft seas, and 43-ft swells as much as 40° off the wind. The VAN ENTERPRISE (44°N, 165°E) had southerly 68-kn winds within a few mb of the center. At 0000 on the 30th the storm's pressure had dropped to 941 mb. The island of Ostrov Beringa broadcast a pressure of 941.8 mb. This corresponds to 27.81 in of mercury or an elevation of about 2,000 ft in the standard atmosphere. The SHOZUI MARU had a pressure of 951 mb at 0300 near 52°N, 169°E. Her winds were 68 kn and waves 39 ft. Several other ships had winds near 60 kn and waves over 30 ft.

In the meantime a peripheral LOW had formed off northern Honshu and it was moving around the outer circulation. On the 31st it turned northwestward and by January 1 was the only circulation. The central pressure had risen to 958 mb. A ship near 47°N, 175°E, had 33-ft seas and 39-ft swells. On the 1st, the maximum winds were near 50 kn and waves 25 ft. This LOW dominated the area from latitudes 30° to 70°N and longitudes 140°E to 150°W. The storm was now stalled near 57°N, 167°E, and filling. On the 3d it started moving eastward again, but early on the 4th it dissappeared.

Casualties--The 90-ft American research vessel HO-LO HOLO was declared missing on the 11th off Hawaii with 10 people aboard. The Indian bulkcarrier CHENNAI SADHAHAI bound from Vancouver to Osaka reported heavy-weather damage. The Singapore-registered KEYAKI (18,707 tons) bulkcarrier reported weather damage on the 11th. The 999-ton CLAVERIA CLIPPER sank in heavy weather west of northern Luzon on the 12th. Four crew were dead and four missing. The Japanese AZUMA MARU No. 18 ran aground in heavy weather off northwest Borneo on the 13th after engine failure. The Panamanian cargo vessel NEW SOUTH SEAS had heavy-weather damage on the 18th.

The pilot of a Cessna 182 that developed fuel problems while being ferried to Honolulu on the 6th ditched the aircraft near the containership MANULANI about 240 mi northeast of Honolulu. The pilot was rescued by the ship's crew.

The 9,110-ton American JOHN TYLER reported heavy-weather damage on the 29th. The Singapore NEPTUNE EMERALD reported damage to the gangway by weather. The 2,838-ton Panamanian KALANTAS ran aground in heavy weather off Amino, Japan, on the 30th. All the crew were rescued by helicopter.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

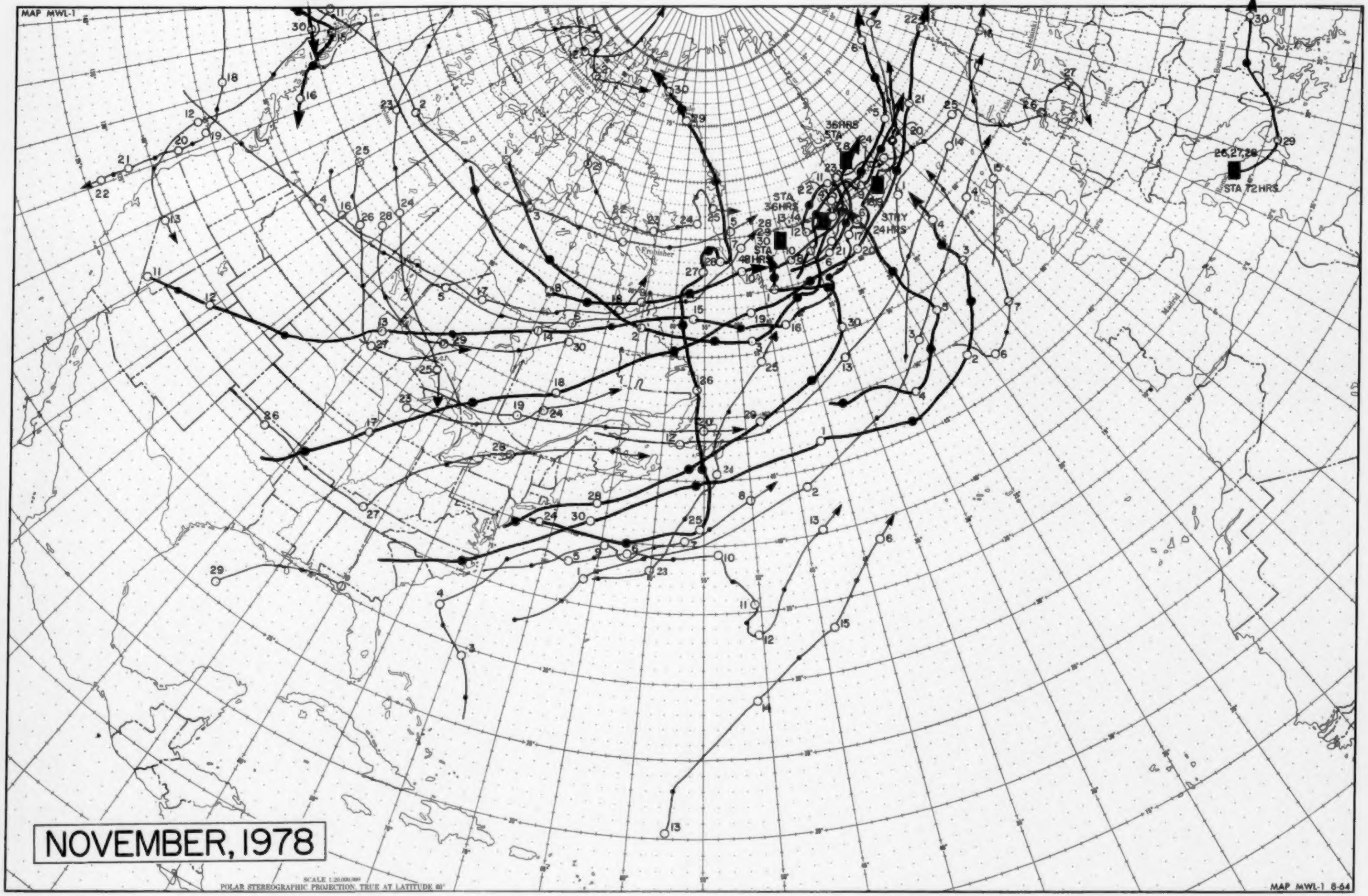

Figure 62. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

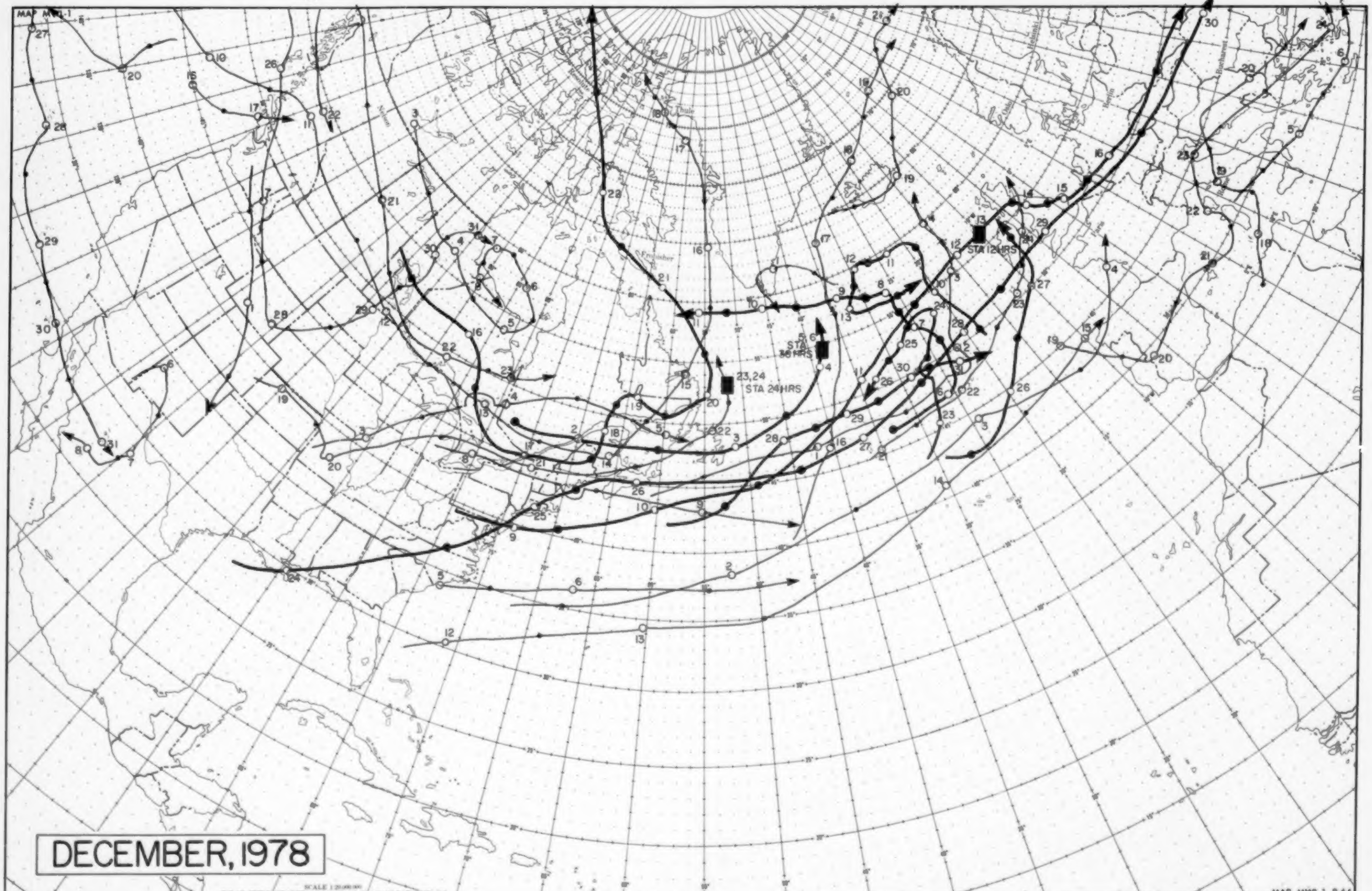

Figure 63. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

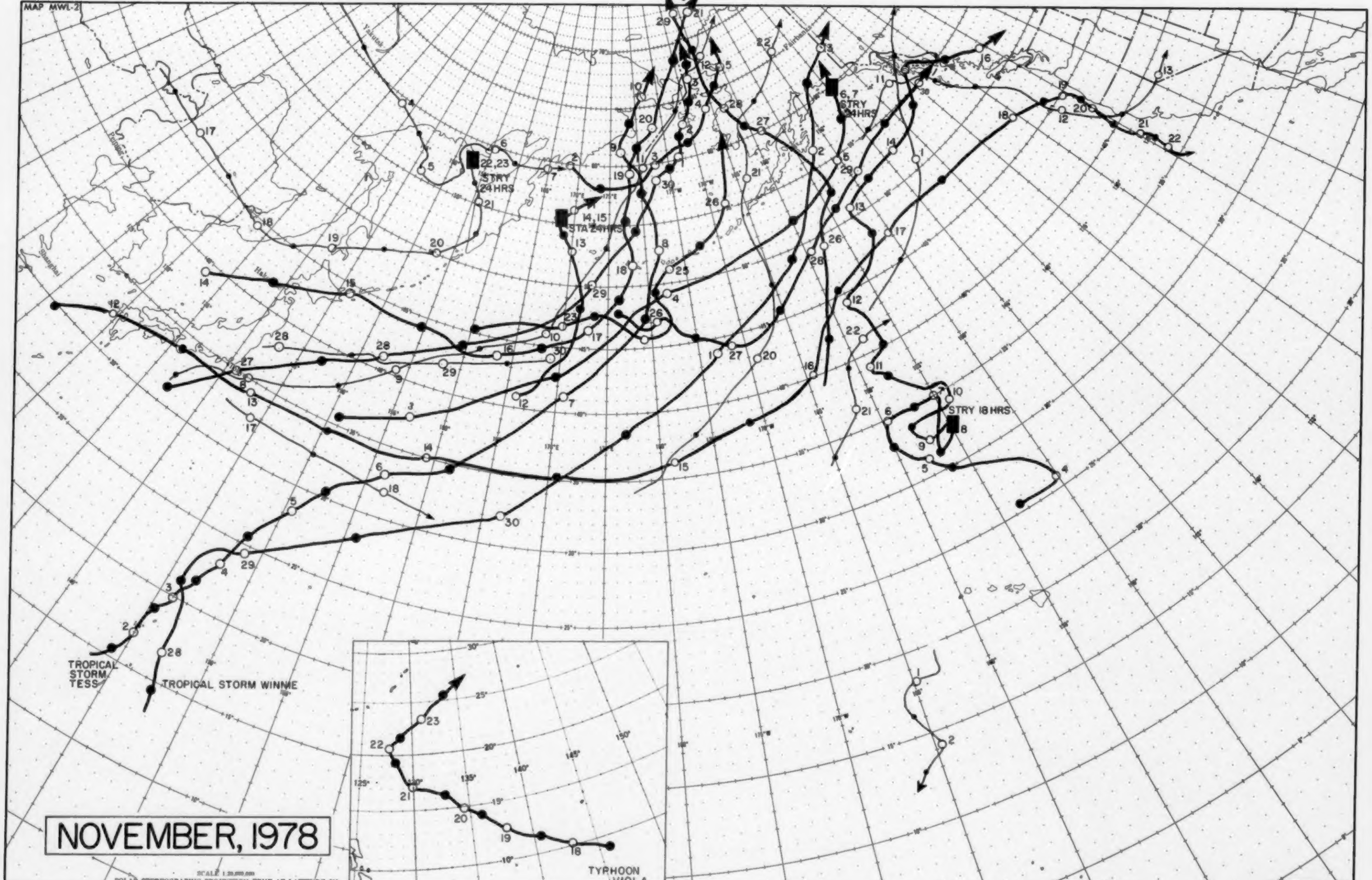

Figure 64. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

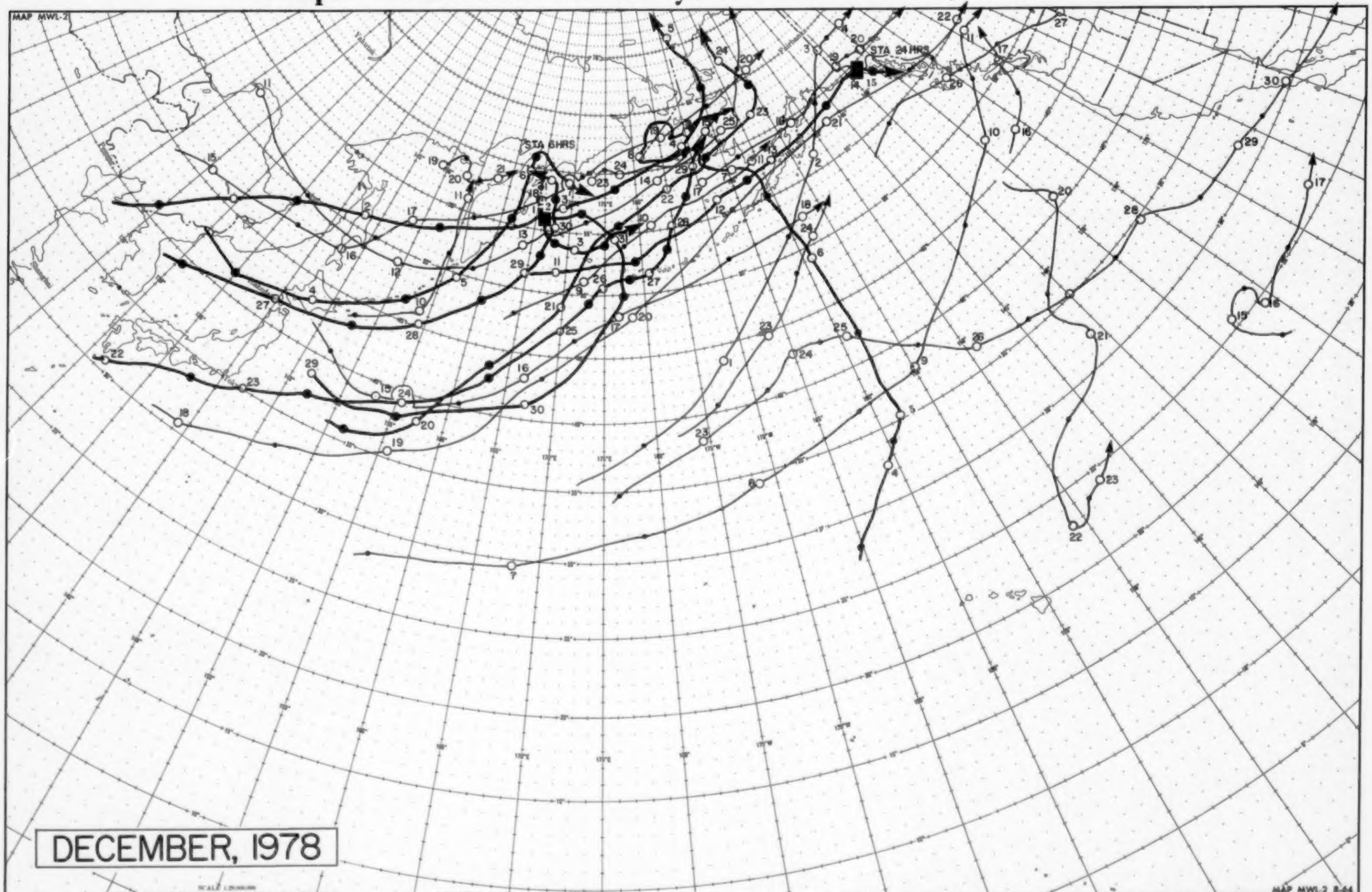

Figure 65. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

U.S. Ocean Buoy Climatological Data

November and December 1978

NOVEMBER — D A T A S U M M A R Y — 41001

AVERAGE LATITUDE 35.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.0	(27 03)	20.7	23.8	(28 18)	238	30
SEA TEMP (DEG C)	23.0	(22 00)	23.4	24.1	(28 08)	238	30
AIR-SEA TEMP (DEG C)	-08.8	(30 03)	-02.7	00.2	(08 15)	238	30
PRESSURE (MBAR)	1005.0	(24 18)	1020.3	1028.6	(20 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	3.8	13.0	2.1			18.3	14.6
NE	.4	1.3	8.0	.8			10.5	14.6
E		3.4	8.4	1.7			13.4	14.1
SE	.8	3.8	3.8	.4			8.8	11.1
S	1.7	2.1	8.4	1.3	.8		14.3	14.8
SW	.4	4.2	2.8	2.5			10.1	14.8
W	.8	4.2	5.0	1.3			11.3	13.1
NW		.4	5.5	5.5			11.3	18.8
CALM	.8						.8	.0
TOTAL	5.5	23.1	56.0	15.5	.8		100.0	14.6

MAX WIND
SPEED: 34 KNOTS
DIRECTION: 200 DEG
DAY: 28
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.4	58.4	28.8	10.8	.4				1.8M	4.0M	(25 03)

NOVEMBER — D A T A S U M M A R Y — 41004

AVERAGE LATITUDE 32.6N AVERAGE LONGITUDE 078.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.8	(25 18)	21.1	25.4	(30 03)	236	30
SEA TEMP (DEG C)	22.5	(08 00)	24.7	26.1	(16 00)	236	30
AIR-SEA TEMP (DEG C)	-11.5	(25 18)	-03.6	01.4	(30 03)	236	30
PRESSURE (MBAR)	1010.8	(04 08)	1020.3	1028.6	(20 15)	236	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 236

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	8.8	13.1	2.1			24.6	12.5
NE	1.3	3.0	25.8	1.7			31.8	15.2
E	1.7	2.1	2.1				5.8	9.2
SE	.4	6.4	2.5				8.3	8.0
S	.8	3.4	5.1	1.3			10.6	13.5
SW		.8	5.1	.4			6.4	15.3
W	.4	2.5	2.1	.8			5.8	12.4
NW		3.0	1.7				4.7	8.3
CALM	.8						.8	.0
TOTAL	5.6	30.1	57.6	6.4			100.0	12.8

MAX WIND
SPEED: 24 KNOTS
DIRECTION: 180 DEG
DAY: 27
HOUR: 15

NOVEMBER — D A T A S U M M A R Y — 42001

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 080.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.1	(08 08)	24.6	26.2	(27 15)	220	30
SEA TEMP (DEG C)	24.7	(28 21)	25.7	26.6	(01 18)	161	30
AIR-SEA TEMP (DEG C)	-04.7	(08 08)	-01.1	01.2	(28 21)	161	30
PRESSURE (MBAR)	1008.7	(27 00)	1017.8	1023.1	(02 15)	227	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 220

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	5.3	3.8				10.5	8.6
NE	.4	15.8	13.6				28.8	8.7
E	.8	25.0	10.1				36.0	8.5
SE	.4	7.8	2.2				10.5	8.1
S		4.4	5.7				10.1	10.7
SW		1.3	.4				1.8	8.3
W		.8					.8	6.0
NW		.4					.4	6.0
CALM								
TOTAL	3.1	61.0	36.0				100.0	8.0

MAX WIND
SPEED: 16 KNOTS
DIRECTION: 170 DEG
DAY: 27
HOUR: 15

NOVEMBER — D A T A S U M M A R Y — 42002

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 083.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.7	(28 00)	24.8	26.7	(06 21)	240	30
SEA TEMP (DEG C)	25.6	(28 00)	26.3	27.0	(01 21)	240	30
AIR-SEA TEMP (DEG C)	-04.5	(08 03)	-01.3	00.2	(24 15)	240	30
PRESSURE (MBAR)	1006.7	(26 21)	1017.1	1023.5	(02 15)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 240

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	1.3	6.3				8.3	12.4
NE	.4	2.1	9.2				11.7	13.4
E		11.7	21.3				32.8	11.8
SE	1.7	6.3	18.8				26.7	12.1
S	.8	5.4	7.5				13.8	11.5
SW	.4	1.3	.8				2.5	8.7
W	.4	.4					.8	5.0
NW		1.3	2.1				3.3	11.0
CALM								
TOTAL	4.6	28.6	65.8				100.0	11.8

MAX WIND
SPEED: 20 KNOTS
DIRECTION: 070 DEG
DAY: 28
HOUR: 21

NOVEMBER — D A T A S U M M A R Y — 42003

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.7	(13 12)	24.6	27.0	(30 21)	238	30
SEA TEMP (DEG C)	24.8	(24 12)	25.7	27.0	(28 21)	238	30
AIR-SEA TEMP (DEG C)	-02.8	(28 18)	-01.1	01.0	(27 21)	238	30
PRESSURE (MBAR)	1011.8	(26 21)	1018.5	1022.5	(18 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		8.8	2.1				10.8	8.4
NE	1.7	11.7	28.8				42.3	11.8
E	2.1	7.8	15.8				25.8	10.3
SE		3.3	7.1				10.5	11.6
S		1.7	5.8				7.5	12.6
SW			.4				.4	15.0
W		.8					.8	5.6
NW		.8	.8				1.7	8.8
CALM								
TOTAL	3.8	35.1	61.1				100.0	11.0

MAX WIND
SPEED: 18 KNOTS
DIRECTION: 160 DEG
DAY: 27
HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	18.5	73.8	7.6						1.1M	3.5M	(28 00)

DECEMBER — D A T A S U M M A R Y — 41001

AVERAGE LATITUDE 35.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.3	(28 12)	17.0	23.5	(06 00)	242	31
SEA TEMP (DEG C)	21.4	(18 00)	22.4	23.7	(01 09)	243	31
AIR-SEA TEMP (DEG C)	-12.7	(28 12)	-05.3	01.3	(10 03)	242	31
PRESSURE (MBAR)	1000.2	(21 18)	1016.5	1035.8	(31 15)	243	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 243

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.7	9.1	1.6	.4		14.8	15.7
NE		1.6	1.2	2.5			5.3	17.2
E		3.7	2.5	.4			6.6	11.0
SE	.8	2.5	1.2	1.2			5.8	12.8
S		1.6	2.5	2.1			6.2	17.5
SW	.4	.8	11.9	10.7	.8		24.7	21.4
W	1.2	2.5	1.6	6.2	1.6		13.2	20.5
NW	.4	2.5	8.6	7.8	2.5		21.8	20.8
CALM	1.6						1.6	.0
TOTAL	4.5	18.8	38.7	32.5	5.3		100.0	18.3

MAX WIND
SPEED: 38 KNOTS
DIRECTION: 310 DEG
DAY: 18
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 243

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.2	38.7	25.8	18.1	14.8	1.2			2.4M	6.0M	(18 12)

DECEMBER — D A T A S U M M A R Y — 41004

AVERAGE LATITUDE 32.6N AVERAGE LONGITUDE 078.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.0	(10 15)	17.2	25.2	(05 03)	240	31
SEA TEMP (DEG C)	18.1	(30 00)	22.2	24.4	(01 03)	240	31
AIR-SEA TEMP (DEG C)	-15.2	(10 15)	-05.0	01.5	(09 06)	240	31
PRESSURE (MBAR)	1000.8	(25 00)	1020.7	1031.5	(30 15)	240	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 240

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	6.9	9.7	2.8			19.8	13.5
NE	.8	5.6	10.1	.8			17.3	13.6
E	1.6	2.0	3.6				7.3	10.4
SE	.8	2.8	2.8				6.5	8.7
S	1.2	6.9	4.4				12.5	8.7
SW	.4	.4	7.3	5.2			13.3	18.3
W	.4	1.6	10.1	2.4			14.5	16.8
NW	.4	2.4	4.4	.8			8.1	12.8
CALM	.8						.8	.0
TOTAL	6.9	28.6	52.4	12.1			100.0	13.5

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 310 DEG
DAY: 17
HOUR: 12

DECEMBER — D A T A S U M M A R Y — 42001

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 080.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	14.8	(10 08)	21.8	26.2	(07 15)	245	31
SEA TEMP (DEG C)	23.0	(31 06)	24.3	25.8	(03 15)	232	31
AIR-SEA TEMP (DEG C)	-10.1	(10 08)	-02.6	01.6	(08 21)	232	31
PRESSURE (MBAR)	1007.8	(24 09)	1017.6	1028.2	(12 15)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 245

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.2	6.5	8.4	1.6			18.8	12.5
NE	.8	9.8	9.8	.8			21.2	10.7
E	3.3	13.5	2.0	.8			18.6	7.2
SE	.8	8.6	11.0				20.4	8.8
S	.8	6.1	5.3				12.2	8.6
SW		.4	.8				1.2	10.7
W		2.0	.4				2.4	7.7
NW		1.6	2.0				3.7	10.8
CALM	.4						.4	.0
TOTAL	7.3	40.6	40.8	3.3			100.0	8.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 070 DEG
DAY: 27
HOUR: 18

DECEMBER — D A T A S U M M A R Y — 42002

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 083.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.6	(10 00)	21.8	26.4	(02 21)	247	31
SEA TEMP (DEG C)	23.1	(25 00)	24.6	25.8	(02 12)	247	31
AIR-SEA TEMP (DEG C)	-11.5	(10 00)	-02.7	00.8	(08 15)	247	31
PRESSURE (MBAR)	1008.2	(24 08)	1017.8	1031.4	(12 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 247

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.2	6.5	3.2			13.0	15.8
NE		8.5	10.8	2.0			21.5	12.8
E		6.9	8.8				15.8	12.3
SE		3.6	15.4	.8			19.8	14.5
S		4.5	17.0	1.6			23.1	14.4
SW	.8	.4	1.2				2.4	11.0
W		.4	.8				1.2	15.0
NW	.4		2.0	.8			3.2	18.3
CALM								
TOTAL	1.2	27.5	62.8	8.5			100.0	14.0

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 330 DEG
DAY: 08
HOUR: 12

DECEMBER — D A T A S U M M A R Y — 42003

AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	15.8	(27 21)	23.0	27.5	(02 18)	240	31
SEA TEMP (DEG C)	23.3	(30 06)	25.8	27.6	(10 00)	240	31
AIR-SEA TEMP (DEG C)	-10.2	(10 21)	-02.8	01.7	(21 03)	240	31
PRESSURE (MBAR)	1008.2	(24 12)	1018.5	1027.6	(12 15)	240	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	7.5	8.8	.8			18.4	11.5
NE	.8	9.6	10.5	2.5			23.4	13.1
E	2.5	2.5	15.1	.4			20.5	13.5
SE	1.3	2.1	10.8				14.2	12.6
S		2.8	11.7	.4			15.1	12.8
SW		1.3	1.7	.8			3.8	15.3
W	.4	.4	.4	.4			1.7	10.8
NW		.8	2.1				2.8	13.4
CALM								
TOTAL	6.3	27.2	61.1	5.4			100.0	12.8

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 080 DEG
DAY: 28
HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	5.8	56.3	30.3	8.3	1.3				1.6M	4.0M	(28 15)

NOVEMBER — DATA SUMMARY — 44001
AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.6W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.1	(28 15)	12.8	17.7	(18 06)	238	30
SEA TEMP (DEG C)	12.8	(30 21)	14.5	16.7	(24 03)	238	30
AIR-SEA TEMP (DEG C)	-10.1	(28 15)	-01.8	03.2	(18 06)	238	30
PRESSURE (MBAR)	1004.2	(24 18)	1020.6	1033.3	(20 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 31

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			9.7				9.7	13.7
NE		32.3	19.4				51.6	10.6
E	3.2						3.2	3.1
SE								
S								
SW								
W	3.2	16.1					19.4	7.2
NW		12.9	3.2				16.1	8.0
CALM								
TOTAL	6.5	61.3	32.3				100.0	9.6

MAX WIND
SPEED: 16 KNOTS
DIRECTION: 360 DEG
DAY: 04
HOUR: 18

NOVEMBER — DATA SUMMARY — 44002
AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.4	(27 12)	08.7	17.5	(18 18)	110	16
SEA TEMP (DEG C)	11.8	(30 21)	12.8	14.0	(15 18)	110	16
AIR-SEA TEMP (DEG C)	-11.5	(27 12)	-04.1	03.7	(18 18)	110	16
PRESSURE (MBAR)	1002.3	(24 18)	1021.5	1034.8	(20 15)	110	16

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 109

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	3.7	15.6				20.2	12.0
NE	.9	7.3	6.4				14.7	9.7
E		1.8	11.9	2.8			16.5	17.1
SE		1.8	.9				2.8	11.0
S		.9	4.6	.9			6.4	16.0
SW		.9	3.7	.9			5.5	14.5
W		.9	10.1	2.8			13.8	17.8
NW		2.8	11.0	6.4			20.2	17.8
CALM								
TOTAL	1.8	20.2	64.2	13.8			100.0	14.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 280 DEG
DAY: 28
HOUR: 00

NOVEMBER — DATA SUMMARY — 44003
AVERAGE LATITUDE 40.8N — AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.8	(26 18)	08.8	15.3	(18 15)	237	30
SEA TEMP (DEG C)	10.3	(27 03)	11.8	12.8	(04 12)	236	30
AIR-SEA TEMP (DEG C)	-10.4	(28 18)	-02.0	03.3	(18 15)	236	30
PRESSURE (MBAR)	0987.0	(24 18)	1020.5	1037.4	(17 12)	237	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 236

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.7	3.0	13.6	.4			18.5	12.2
NE	.8	2.1	14.8				17.8	13.7
E	.4	4.7	12.7	1.3			19.1	12.8
SE		2.1	3.8	.8			6.8	15.1
S		1.3	3.0	.4			4.7	14.2
SW	.4	.8	4.7				5.9	12.1
W	.4	2.5	7.2	.8			11.0	13.3
NW		1.3	8.9	5.1			15.3	17.7
CALM								
TOTAL	3.0	18.6	68.6	8.8			100.0	13.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 310 DEG
DAY: 28
HOUR: 00

NOVEMBER — DATA SUMMARY — 44004
AVERAGE LATITUDE 38.0N — AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.2	(26 18)	15.0	21.8	(18 12)	237	30
SEA TEMP (DEG C)	17.1	(30 15)	20.5	23.8	(08 06)	237	30
AIR-SEA TEMP (DEG C)	-14.6	(28 18)	-05.4	01.3	(18 03)	237	30
PRESSURE (MBAR)	1000.3	(24 18)	1020.8	1034.2	(17 12)	237	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 237

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.7	16.9	3.0			21.9	16.9
NE	.4	3.4	15.6	5.9			25.3	16.8
E	.4	2.5	5.1	2.5			10.5	15.5
SE			2.1	2.5			4.6	21.0
S		.4	2.1	3.0			5.5	23.3
SW		.8	4.2	3.8	.4		9.3	18.8
W	.4	1.3	5.5	2.1			9.3	16.7
NW		.8	4.6	7.6	.4		13.5	22.6
CALM								
TOTAL	1.7	11.0	56.1	30.4	.8		100.0	18.3

MAX WIND
SPEED: 35 KNOTS
DIRECTION: 240 DEG
DAY: 30
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 231

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		46.3	37.2	12.6	3.8				2.0M	4.5M (28 18)

NOVEMBER — DATA SUMMARY — 46002
AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.2	(30 06)	13.3	17.4	(04 00)	234	30
SEA TEMP (DEG C)	14.5	(30 15)	15.6	16.8	(02 00)	234	30
AIR-SEA TEMP (DEG C)	-07.0	(20 06)	-02.3	00.8	(04 00)	234	30
PRESSURE (MBAR)	1007.8	(18 03)	1022.2	1031.1	(04 18)	234	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 234

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	4.3	14.5	8.1			27.8	17.3
NE	.4	1.7	3.4	4.7			10.3	18.8
E		1.3					1.3	7.0
SE	.8	1.3					2.1	5.0
S		1.7	1.7	1.3			4.7	14.7
SW	.4	4.3	12.0	1.7			18.4	13.7
W		5.1	13.2	2.1			20.5	14.6
NW	.9	4.7	6.0	3.0			14.5	14.4
CALM	.4						.4	.0
TOTAL	3.0	24.4	50.8	20.9			100.0	15.0

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 360 DEG
DAY: 21
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 234

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		18.2	40.6	34.2	6.0				2.5M	4.5M (18 21)

NOVEMBER — DATA SUMMARY — 46003
AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.6	(30 08)	06.3	08.0	(28 15)	112	14
SEA TEMP (DEG C)	06.0	(27 15)	06.3	06.6	(24 18)	112	14
AIR-SEA TEMP (DEG C)	-02.8	(30 08)	00.0	02.6	(26 15)	112	14
PRESSURE (MBAR)	0956.9	(26 21)	1005.0	1031.4	(20 09)	112	14

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 104

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.9	2.9				4.8	9.4
NE								
E		1.9	1.9	2.9			6.7	17.5
SE		8.7	4.8	5.8			19.2	15.1
S	1.0	3.8	21.2	8.7			34.6	17.4
SW	1.0	2.9	9.6	3.8			17.3	15.7
W		3.8	1.0	4.8			9.6	18.7
NW		2.9	3.8				6.7	11.1
CALM	1.0						1.0	.0
TOTAL	2.9	26.0	45.2	26.0			100.0	15.8

MAX WIND
SPEED: 33 KNOTS
DIRECTION: 280 DEG
DAY: 27
HOUR: 03

DECEMBER — DATA SUMMARY — 44001
AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.6W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.8	(11 12)	08.1	18.4	(04 18)	247	31
SEA TEMP (DEG C)	11.6	(31 21)	12.4	13.7	(01 12)	247	31
AIR-SEA TEMP (DEG C)	-1[illegible].0	(11 12)	-04.4	03.5	(08 15)	247	31
PRESSURE (MBAR)	0986.3	(26 06)	1017.5	1039.6	(30 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 154

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	9.7	7.8				18.8	10.3
NE	1.3						1.3	2.5
E	1.3	.6	1.3				3.2	9.6
SE	.7	.6	1.3	.6			3.2	11.4
S	1.3	5.2	1.3				7.8	7.3
SW	.6	1.9	5.2	1.3			9.1	15.4
W		5.8	10.4	3.9			20.1	15.9
NW	.6	5.8	21.4	8.4			36.4	17.7
CALM								
TOTAL	7.1	20.8	48.7	14.3			100.0	14.3

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 280 DEG
DAY: 25
HOUR: 08

DECEMBER — DATA SUMMARY — 44002
AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.7	(11 12)	07.1	15.2	(04 18)	164	25
SEA TEMP (DEG C)	10.0	(25 03)	11.1	12.0	(05 03)	164	25
AIR-SEA TEMP (DEG C)	-12.5	(11 12)	-04.0	03.3	(04 18)	164	25
PRESSURE (MBAR)	0988.5	(21 12)	1015.5	1033.4	(11 15)	164	25

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 162

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.6	.6	3.1				4.3	12.0
NE		.6	.6				1.2	8.5
E	.6	4.3	1.9	.6	.6		8.0	12.3
SE	.6	1.2	3.7				5.6	11.9
S		1.9	5.6	2.5			9.9	15.5
SW	.6	2.5	12.3	6.8			22.2	18.6
W		4.9	14.2	14.8	1.2		35.2	18.0
NW		1.9	6.8	3.7	1.2		13.6	20.7
CALM								
TOTAL	2.5	17.9	48.1	28.4	3.1		100.0	17.3

MAX WIND
SPEED: 38 KNOTS
DIRECTION: 310 DEG
DAY: 18
HOUR: 15

DECEMBER — DATA SUMMARY — 44003
AVERAGE LATITUDE 40.0N — AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.8	(11 15)	08.1	15.1	(04 21)	103	13
SEA TEMP (DEG C)	08.2	(07 08)	10.1	11.4	(13 21)	103	13
AIR-SEA TEMP (DEG C)	-10.0	(11 15)	-01.8	05.1	(04 21)	103	13
PRESSURE (MBAR)	0988.3	(10 08)	1016.8	1030.0	(12 00)	103	13

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 103

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.9	10.7	4.9				18.4	8.8
NE		1.0					1.0	8.0
E		6.8	1.0				7.8	8.8
SE		2.9	2.9				5.8	11.7
S	1.0	1.0	5.8	1.0			8.7	15.8
SW		3.9	11.7	1.0			16.5	13.4
W		5.8	10.7	1.0			19.4	12.3
NW		11.7	8.7	2.9			23.3	13.2
CALM								
TOTAL	3.9	44.7	45.6	5.8			100.0	11.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 320 DEG
DAY: 10
HOUR: 08

DECEMBER — DATA SUMMARY — 44004
AVERAGE LATITUDE 38.0N — AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	02.0	(27 15)	08.5	20.3	(08 15)	247	31
SEA TEMP (DEG C)	08.1	(28 03)	14.3	18.3	(14 08)	247	31
AIR-SEA TEMP (DEG C)	-13.2	(18 08)	-04.8	04.6	(25 08)	247	31
PRESSURE (MBAR)	0981.8	(21 18)	1017.4	1037.5	(31 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 247

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		4.5	8.1	.4			13.0	13.0
NE		2.8	2.0				4.8	9.3
E		3.6	1.2	.4	.8		6.1	13.7
SE	.4	.8	2.0				3.2	12.1
S	.4	1.2	1.6	2.4			5.7	18.0
SW		2.4	4.5	10.5			17.4	22.5
W		2.0	8.7	9.1	5.3		25.1	23.0
NW	.8	2.4	6.5	11.3	3.6		24.7	23.0
CALM								
TOTAL	1.6	18.8	35.6	33.2	9.7		100.0	18.7

MAX WIND
SPEED: 44 KNOTS
DIRECTION: 310 DEG
DAY: 18
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 246

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	1.6	41.1	18.5	22.8	10.2	4.8			2.5M	7.0M (18 12)

DECEMBER — DATA SUMMARY — 46002
AVERAGE LATITUDE 42.5N — AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.4	(17 18)	11.0	15.0	(10 21)	242	31
SEA TEMP (DEG C)	12.4	(31 03)	13.6	14.6	(04 08)	242	31
AIR-SEA TEMP (DEG C)	-07.8	(17 18)	-02.6	01.1	(10 21)	242	31
PRESSURE (MBAR)	1002.0	(17 00)	1025.0	1036.8	(05 18)	242	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 243

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	5.3	16.9	3.3			26.3	15.0
NE		2.1	14.4	2.9			18.3	17.0
E		1.6	.4				2.1	7.4
SE		1.6	1.2				2.8	10.0
S	.4	3.7	3.7	2.9			10.7	15.1
SW		2.1	4.9	1.2			8.2	14.8
W	.4	4.5	11.5	.8			17.3	13.8
NW	.4	2.5	5.3	4.9			13.2	16.8
CALM								
TOTAL	2.1	23.5	58.4	16.0			100.0	15.1

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 320 DEG
DAY: 17
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 243

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY		8.9	40.8	24.3	13.8	2.5			2.8M	7.0M (17 12)

DECEMBER — DATA SUMMARY — 46003
AVERAGE LATITUDE 52.0N — AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.5	(15 18)	04.4	07.1	(22 15)	100	24
SEA TEMP (DEG C)	04.7	(28 06)	05.0	05.7	(08 15)	101	24
AIR-SEA TEMP (DEG C)	-04.5	(15 18)	-00.6	02.2	(22 15)	100	24
PRESSURE (MBAR)	0964.8	(12 12)	1009.5	1037.7	(18 21)	101	24

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 100

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N			.5	.5			1.1	21.0
NE			2.1				2.1	18.3
E		1.1	3.7	.5			5.3	15.3
SE		.5	6.8	3.7			11.1	18.5
S		2.6	5.3	2.1			10.0	16.0
SW		3.7	14.2	3.2			21.1	18.0
W		2.1	25.3	14.2			41.6	18.5
NW		1.1	5.3	1.6			7.9	17.1
CALM								
TOTAL		11.1	63.2	25.8			100.0	17.5

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 290 DEG
DAY: 13
HOUR: 12

```
NOVEMBER                          D A T A     S U M M A R Y                         46004
          AVERAGE LATITUDE  51.0N                      AVERAGE LONGITUDE  136.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     04.6    (19 00)   !    08.5   !   13.1   (01 15)  !   238  !    30
    SEA  TEMP (DEG C)     08.4    (30 21)   !    10.2   !   11.6   (01 18)  !   238  !    30
 AIR-SEA TEMP (DEG C)    -05.2    (18 00)   !   -01.7   !   01.5   (01 15)  !   238  !    30
    PRESSURE  (MBAR)    0981.3    (01 18)   !  1018.6   ! 1040.8   (09 18)  !   238  !    30
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   238
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !            .8    4.6   10.9                 !  16.4 ! 22.1        MAX WIND
    NE  !                   .4    1.3                 !   1.7 ! 23.3    SPEED:  46 KNOTS
    E   !            .4           1.7     .4          !   2.5 ! 26.5    DIRECTION: 200 DEG
    SE  !            .8    4.6     .8                 !   6.3 ! 16.3    DAY:    01
    S   !     .4     .4    3.8    7.1    1.7          !  13.4 ! 24.8    HOUR:   18
    SW  !            .4    6.3    8.7    2.9          !  18.3 ! 24.4
    W   !     .8    1.7   12.6   13.0     .4          !  28.6 ! 20.3
    NW  !                  6.3    4.2     .8          !  11.3 ! 20.7
   CALM !     .4                                      !    .4 !   .0
  TOTAL !    1.7    4.6   38.7   48.7    8.3          ! 100.0 ! 21.8
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   238
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY        11.3  33.5  25.5  24.7   5.0              ! 3.1M   7.0M (01 21)
-----------------------------------------------------------------------------------------
```

```
NOVEMBER                          D A T A     S U M M A R Y                         46005
          AVERAGE LATITUDE  46.0N                      AVERAGE LONGITUDE  131.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     08.3    (20 00)   !    11.3   !   15.6   (02 00)  !   240  !    30
    SEA  TEMP (DEG C)     11.8    (30 21)   !    13.0   !   14.3   (02 03)  !   240  !    30
 AIR-SEA TEMP (DEG C)    -04.3    (18 12)   !   -01.6   !   01.4   (07 08)  !   240  !    30
    PRESSURE  (MBAR)    1000.1    (16 12)   !  1020.8   ! 1033.2   (08 18)  !   240  !    30
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   240
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !           3.3   14.2   16.7     .4          !  34.6 ! 19.8        MAX WIND
    NE  !     .4     .8    2.1    2.1                 !   5.4 ! 16.0    SPEED:  36 KNOTS
    E   !     .4     .8     .4                        !   1.7 !  7.3    DIRECTION: 010 DEG
    SE  !            .8    2.1    1.3                 !   4.2 ! 16.8    DAY:    19
    S   !           2.5    3.3    7.5                 !  13.3 ! 18.8    HOUR:   05
    SW  !     .8     .8    8.3    2.1                 !  12.1 ! 15.8
    W   !           3.3    7.9    2.9                 !  14.2 ! 18.2
    NW  !           2.5    8.3    3.3     .4          !  14.6 ! 17.1
   CALM !                                             !       !
  TOTAL !    1.7   15.0   46.7   35.8     .8          ! 100.0 ! 17.8
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   240
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY        23.8  38.7  26.6  10.0                    ! 2.5M   4.5M (18 18)
-----------------------------------------------------------------------------------------
```

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NOVEMBER                          D A T A     S U M M A R Y                         46006
          AVERAGE LATITUDE  41.0N                      AVERAGE LONGITUDE  138.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     11.0    (25 06)   !    14.6   !   18.3   (18 03)  !   238  !    30
    SEA  TEMP (DEG C)     15.2    (20 08)   !    16.1   !   17.2   (01 08)  !   238  !    30
 AIR-SEA TEMP (DEG C)    -05.2    (02 12)   !   -01.5   !   02.5   (18 03)  !   238  !    30
    PRESSURE  (MBAR)    1012.4    (15 00)   !  1025.6   ! 1034.5   (04 21)  !   238  !    30
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   124
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !           3.2    4.0    2.4                 !   9.7 ! 16.1        MAX WIND
    NE  !           4.0   12.8     .8                 !  17.7 ! 13.7    SPEED:  27 KNOTS
    E   !           3.2   11.3    2.4                 !  16.9 ! 16.0    DIRECTION: 010 DEG
    SE  !     .8    1.6    4.0                        !   6.5 ! 12.0    DAY:    03
    S   !                 19.3    6.5                 !  21.8 ! 19.8    HOUR:   21
    SW  !           4.8    8.5    2.4                 !  15.7 ! 14.8
    W   !            .8    6.5    2.4                 !   9.7 ! 19.5
    NW  !                  4.0                        !   4.0 ! 14.6
   CALM !                                             !       !
  TOTAL !     .8   17.7   64.5   16.9                 ! 100.0 ! 16.3
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   122
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY        12.3  70.5  16.4    .8                    ! 2.3M   4.0M (02 03)
-----------------------------------------------------------------------------------------
```

```
NOVEMBER                          D A T A     S U M M A R Y                         46007
          AVERAGE LATITUDE  56.2N                      AVERAGE LONGITUDE  152.7W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)    -02.8    (05 03)   !    03.2   !   07.1   (26 18)  !   187  !    30
    SEA  TEMP (DEG C)     06.5    (28 00)   !    08.0   !   09.5   (01 15)  !   187  !    30
 AIR-SEA TEMP (DEG C)    -11.1    (02 21)   !   -04.7   !  -00.1   (26 18)  !   195  !    30
    PRESSURE  (MBAR)    0969.7    (06 00)   !  1010.8   ! 1038.6   (18 21)  !   196  !    30
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   193
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !     .5    4.1    7.3     .5                 !  12.4 ! 12.8        MAX WIND
    NE  !           1.6   18.1    3.1                 !  22.8 ! 17.7    SPEED:  34 KNOTS
    E   !     .5     .5    3.1    1.0     .5          !   5.7 ! 17.2    DIRECTION: 100 DEG
    SE  !    1.0    3.1   13.5    2.6                 !  20.2 ! 15.3    DAY:    27
    S   !    1.0    2.6    4.7                        !   8.3 ! 10.2    HOUR:   03
    SW  !           1.6    1.0                        !   2.6 ! 10.4
    W   !     .5    2.1    8.8    9.8                 !  21.2 ! 20.5
    NW  !    1.0    3.6    2.1                        !   6.7 !  9.1
   CALM !                                             !       !
  TOTAL !    4.7   18.2   58.5   17.1     .5          ! 100.0 ! 15.8
-----------------------------------------------------------------------------------------
% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING  MODERATE: 1.6%  SEVERE: NONE #OBS:   192
```

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NOVEMBER                          D A T A     S U M M A R Y                         46008
          AVERAGE LATITUDE  57.1N                      AVERAGE LONGITUDE  151.7W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     00.8    (03 15)   !    04.6   !   06.8   (21 15)  !   235  !    30
    SEA  TEMP (DEG C)     04.7    (30 21)   !    05.1   !   06.0   (02 08)  !   235  !    30
 AIR-SEA TEMP (DEG C)    -04.8    (03 08)   !   -00.5   !   02.1   (22 00)  !   235  !    30
    PRESSURE  (MBAR)    0969.3    (05 21)   !  1010.6   ! 1038.2   (18 21)  !   235  !    30
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   235
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !     .4    2.1   15.3                        !  17.9 ! 13.6        MAX WIND
    NE  !           3.0    2.6                        !   5.5 !  9.5    SPEED:  27 KNOTS
    E   !     .8    2.1    9.4    1.3                 !  13.6 ! 15.0    DIRECTION: 110 DEG
    SE  !     .9    2.1    6.8                        !   9.8 ! 11.8    DAY:    26
    S   !     .4    3.4    7.7     .4                 !  11.9 ! 13.1    HOUR:   21
    SW  !     .8    4.7   10.2     .9                 !  16.6 ! 12.1
    W   !     .8    3.0   10.6    1.3                 !  15.7 ! 13.7
    NW  !           5.1    3.4                        !   8.5 ! 10.2
   CALM !     .4                                      !    .4 !   .0
  TOTAL !    4.7   25.5   66.0    3.8                 ! 100.0 ! 12.7
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   233
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY        12.9  52.4  20.2  12.0   2.6              ! 2.7M   7.5M (27 00)
-----------------------------------------------------------------------------------------
```

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NOVEMBER                          D A T A     S U M M A R Y                         46009
          AVERAGE LATITUDE  60.2N                      AVERAGE LONGITUDE  146.8W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)    -00.7    (16 03)   !    03.6   !   07.3   (26 18)  !   224  !    28
    SEA  TEMP (DEG C)     04.3    (22 18)   !    07.2   !   08.0   (05 12)  !   224  !    28
 AIR-SEA TEMP (DEG C)    -07.9    (16 03)   !   -03.4   !   01.8   (26 21)  !   224  !    28
    PRESSURE  (MBAR)    0958.3    (06 03)   !  1011.0   ! 1042.4   (19 03)  !   224  !    28
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   223
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !    1.3   16.6    9.9                        !  27.8 !  8.9        MAX WIND
    NE  !    1.8    8.1    1.8                        !  11.7 !  7.7    SPEED:  30 KNOTS
    E   !     .9    7.2   19.3    5.4                 !  32.7 ! 15.6    DIRECTION: 110 DEG
    SE  !     .4    2.7    3.6     .4                 !   7.2 ! 12.5    DAY:    26
    S   !           2.2    2.7                        !   4.9 !  8.8    HOUR:   09
    SW  !     .9     .9    2.7                        !   4.5 ! 10.1
    W   !                                             !       !
    NW  !     .4    4.5    5.8                        !  10.8 ! 11.1
   CALM !     .4                                      !    .4 !   .0
  TOTAL !    6.3   42.2   45.7    5.8                 ! 100.0 ! 11.5
-----------------------------------------------------------------------------------------
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```
DECEMBER                          D A T A     S U M M A R Y                         46004
          AVERAGE LATITUDE  51.0N                      AVERAGE LONGITUDE  136.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     02.4    (17 21)   !    06.9   !   10.0   (02 21)  !   247  !    31
    SEA  TEMP (DEG C)     07.8    (29 08)   !    08.7   !   09.7   (02 09)  !   247  !    31
 AIR-SEA TEMP (DEG C)    -06.1    (17 21)   !   -01.8   !   00.6   (31 18)  !   247  !    31
    PRESSURE  (MBAR)    [illegible]8.1    (18 09)   !  1018.3   ! 1040.6   (05 21)  !   247  !    31
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   247
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !     .4    2.4    2.4    6.5     .8          !  12.6 ! 21.4        MAX WIND
    NE  !            .8    1.6     .4                 !   2.8 ! 14.7    SPEED:  44 KNOTS
    E   !                          .4                 !    .4 ! 32.0    DIRECTION: 280 DEG
    SE  !                  1.2     .4    1.2          !   2.8 ! 26.7    DAY:    14
    S   !    1.2    1.6    5.7   10.9    1.6          !  21.1 ! 22.3    HOUR:   15
    SW  !     .4    1.2    3.6    4.9    2.0          !  12.1 ! 22.0
    W   !     .8    1.2    8.9   15.0    4.9          !  30.8 ! 24.7
    NW  !     .8    1.2    5.7    9.3     .4          !  17.4 ! 21.7
   CALM !                                             !       !
  TOTAL !    3.6    8.5   29.1   47.8   10.9          ! 100.0 ! 22.7
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   247
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY    .8   8.1  20.6  34.0  28.3   7.7    .4        ! 3.5M   8.0M (14 15)
-----------------------------------------------------------------------------------------
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DECEMBER                          D A T A     S U M M A R Y                         46005
          AVERAGE LATITUDE  46.0N                      AVERAGE LONGITUDE  131.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     03.8    (18 06)   !    08.3   !   13.2   (10 15)  !   247  !    31
    SEA  TEMP (DEG C)     10.0    (29 18)   !    11.0   !   12.1   (04 00)  !   247  !    31
 AIR-SEA TEMP (DEG C)    -06.5    (18 08)   !   -01.7   !   01.5   (10 15)  !   247  !    31
    PRESSURE  (MBAR)    0985.0    (17 00)   !  1023.2   ! 1038.4   (05 18)  !   247  !    31
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   247
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !     .4    1.6   13.4   11.3    1.2          !  27.9 ! 20.1        MAX WIND
    NE  !           2.4    3.6     .4                 !   6.5 ! 12.3    SPEED:  47 KNOTS
    E   !     .4     .8                               !   1.2 !  7.1    DIRECTION: 340 DEG
    SE  !            .4    2.8     .4     .4          !   4.0 ! 18.3    DAY:    17
    S   !     .8    2.0    4.9    5.3                 !  13.0 ! 18.3    HOUR:   00
    SW  !     .4    2.4    7.3    2.4                 !  12.6 ! 16.0
    W   !           2.4    5.7    5.7                 !  13.8 ! 18.1
    NW  !     .4    2.8    8.1    8.8     .8          !  21.1 ! 18.9
   CALM !                                             !       !
  TOTAL !    2.4   15.0   45.7   34.4    2.4          ! 100.0 ! 18.3
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   247
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY        16.2  31.6  30.0  18.6   3.6              ! 3.0M   6.5M (17 06)
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DECEMBER                          D A T A     S U M M A R Y                         46006
          AVERAGE LATITUDE  41.0N                      AVERAGE LONGITUDE  138.0W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)     05.9    (17 18)   !    12.4   !   16.3   (08 15)  !   228  !    31
    SEA  TEMP (DEG C)     11.8    (31 21)   !    14.2   !   15.9   (07 12)  !   240  !    31
 AIR-SEA TEMP (DEG C)    -07.3    (16 18)   !   -01.8   !   03.0   (30 21)  !   228  !    31
    PRESSURE  (MBAR)    1010.7    (10 15)   !  1026.J   ! 1041.1   (05 18)  !   240  !    31
-----------------------------------------------------------------------------------------
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DECEMBER                          D A T A     S U M M A R Y                         46007
          AVERAGE LATITUDE  56.2N                      AVERAGE LONGITUDE  152.7W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)    -06.1    (16 12)   !    02.0   !   06.9   (05 21)  !   182  !    31
    SEA  TEMP (DEG C)     05.5    (26 18)   !    06.7   !   08.3   (02 12)  !   185  !    31
 AIR-SEA TEMP (DEG C)    -12.7    (14 18)   !   -04.7   !   00.1   (31 00)  !   182  !    31
    PRESSURE  (MBAR)    0965.1    (13 12)   !  1002.8   ! 1030.1   (26 12)  !   180  !    31
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:    61
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !           1.6                               !   1.6 !  9.1        MAX WIND
    NE  !    1.6    1.6    9.8    4.9                 !  18.0 ! 18.0    SPEED:  32 KNOTS
    E   !    1.6   11.5    6.6    1.6                 !  21.3 ! 10.8    DIRECTION: 280 DEG
    SE  !           3.3    6.6    3.3                 !  13.1 ! 15.1    DAY:    03
    S   !    1.6    4.9    4.9                        !  11.5 !  9.8    HOUR:   00
    SW  !           1.6    3.3                        !   4.9 ! 13.3
    W   !    1.6    1.6   13.1    8.2                 !  24.6 ! 19.4
    NW  !           3.3    1.6                        !   4.9 ! 10.3
   CALM !                                             !       !
  TOTAL !    6.6   29.5   45.9   18.0                 ! 100.0 ! 14.7
-----------------------------------------------------------------------------------------
```

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DECEMBER                          D A T A     S U M M A R Y                         46008
          AVERAGE LATITUDE  57.1N                      AVERAGE LONGITUDE  151.7W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)    -02.9    (16 12)   !    03.6   !   06.7   (08 21)  !   237  !    31
    SEA  TEMP (DEG C)     03.4    (29 12)   !    04.1   !   04.7   (03 03)  !   237  !    31
 AIR-SEA TEMP (DEG C)    -06.8    (16 12)   !   -00.9   !   02.2   (08 21)  !   237  !    31
    PRESSURE  (MBAR)    0961.5    (02 15)   !  1004.1   ! 1032.2   (05 21)  !   237  !    31
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   237
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !     .4     .8    1.3                        !   2.5 ! 10.9        MAX WIND
    NE  !                                             !       !         SPEED:  28 KNOTS
    E   !     .4    1.3    6.8                        !   8.4 ! 14.9    DIRECTION: 250 DEG
    SE  !           3.8   13.1                        !  16.9 ! 14.3    DAY:    13
    S   !           4.2    9.3    1.7                 !  15.2 ! 13.6    HOUR:   06
    SW  !           2.1   12.2     .8                 !  15.2 ! 14.7
    W   !           1.7   23.6    8.4                 !  33.8 ! 17.6
    NW  !     .4    2.1    4.2    1.3                 !   8.0 ! 13.5
   CALM !                                             !       !
  TOTAL !    1.3   16.0   70.5   12.2                 ! 100.0 ! 15.2
-----------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME  (METERS)              NO. OF WAVE  OBS:   236
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 ! MEAN   MAX  (DA HR)
% FREQUENCY         8.5  22.5  34.3  33.5   1.3              ! 3.3M   6.0M (23 12)
-----------------------------------------------------------------------------------------
% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING  MODERATE:  .8%  SEVERE: NONE #OBS:   237
```

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DECEMBER                          D A T A     S U M M A R Y                         46009
          AVERAGE LATITUDE  60.2N                      AVERAGE LONGITUDE  146.8W
-----------------------------------------------------------------------------------------
MEANS AND EXTREMES                          !           !                   ! NO. OF ! DAYS WITH
                          MIN     (DA HR)   !    MEAN   !    MAX   (DA HR)  !   OBS  !   DATA
    AIR  TEMP (DEG C)    -03.6    (16 09)   !    01.7   !   06.6   (02 18)  !   246  !    31
    SEA  TEMP (DEG C)     03.7    (23 18)   !    06.1   !   07.3   (08 06)  !   246  !    31
 AIR-SEA TEMP (DEG C)    -10.3    (16 09)   !   -04.4   !   00.6   (07 21)  !   246  !    31
    PRESSURE  (MBAR)    [illegible]    (03 00)   !  1005.1   ! 1034.1   (05 21)  !   246  !    31
-----------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
         ^------- SPEED    (KNOTS) -------------^-------^ MEAN
    ----!            4-    11-    22-    34-          ! TOTAL ! SPEED     NO. OF OBS:   205
    DIR !    <4      10     21     33     47   >47    !   %   ! (KNOTS)
    ----!                                             !       !
    N   !    1.5    2.4    4.9    2.0                 !  10.7 ! 12.8        MAX WIND
    NE  !    1.5    1.5     .5                        !   3.4 !  6.0    SPEED:  28 KNOTS
    E   !    1.0    5.4   25.9   12.2                 !  44.4 ! 17.0    DIRECTION: 100 DEG
    SE  !    1.0    1.0    9.3    1.0                 !  12.2 ! 15.5    DAY:    18
    S   !           1.5    3.9     .5                 !   5.9 ! 12.8    HOUR:   15
    SW  !            .5    2.0                        !   2.4 ! 11.6
    W   !     .5    2.0    1.5                        !   3.9 !  8.7
    NW  !    2.0    4.4    9.3    1.0                 !  16.8 ! 12.5
   CALM !     .5                                      !    .5 !   .0
  TOTAL !    7.8   18.5   57.1   16.6                 ! 100.0 ! 14.5
-----------------------------------------------------------------------------------------
% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING  MODERATE: 6.9%  SEVERE: NONE #OBS:   204
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Continued on page 202.

Table 7
Selected Gale and Wave Observations, North Atlantic

November and December 1978

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH ATLANTIC OCEAN		NOV.															
SEALAND ECONOMY	AMERICAN	1	46.3 N	21.3 W	12	20	45	5 NM	50	1013.2	13.3	15.7	7	8	20	7	19.5
MOHAWK	AMERICAN	1	33.1 N	32.9 W	12	34	45	5 NM	02	1015.2	18.3	23.3	6	19.5			
AMER ACCORD	AMERICAN	4	44.0 N	44.6 W	06	31	45	5 NM	01	1010.8	7.8	17.2					
BALTIMORE TRADER	AMERICAN	25	39.5 N	72.3 W	12	32	45	10 NM	02	1007.5	7.8	14.4	3	14.5	32	6	18
AMER ARCHER	AMERICAN	25	43.1 N	42.0 W	18	16	45	1 NM	02	1006.4	15.6	18.9	5	6.5	14	9	19.5
SEALAND CONSUMER	AMERICAN	26	38.3 N	40.3 W	18	18	41	5 NM	25	1006.0	20.6	17.8	5	13	17	9	14.5
RED JACKET	AMERICAN	26	42.6 N	37.8 W	12	17	50	2 NM	02	1016.0	18.5	17.2	6	19.5	13	6	16.5
EXPORT PATRIOT	AMERICAN	28	45.4 N	31.7 W	20	27	45	10 NM	02	1023.0	12.0	15.6	4	14.5	27	9	19.5
EXPORT PATRIOT	AMERICAN	30	42.7 N	38.8 W	00	28	50	5 NM	02	1000.2	15.6	16.1	4	11.5	25	8	24.5
GEORGE WALTON	AMERICAN	30	46.3 N	31.5 W	06	20	50	2 NM	64	975.5	10.0	13.9			22	6	16.5
AMER ACCORD	AMERICAN	30	45.3 N	35.2 W	11	28	63	2 NM	18	999.9	8.9	12.8		41			
GREAT LAKES VESSELS																	
PHILIP R CLARKE	AMERICAN	5	47.4 N	89.4 W	18	25	M 42	10 NM	03		6.0	13.0	6	8			
ROBERT C STANLEY	AMERICAN	8	46.7 N	85.8 W	22	19	M 56	10 NM	02		10.0			6.5			
JOHN DYKSTRA	AMERICAN	9	44.5 N	82.8 W	06	25	M 42	10 NM	01		8.0	9.0	8	11.5			
MIDDLETOWN	AMERICAN	9	45.4 N	86.3 W	00	21	M 42	10 NM	02		10.0	12.0	4	14.5			
ROBERT C STANLEY	AMERICAN	9	46.7 N	86.1 W	00	19	M 41	10 NM	02		11.0			6.5			
G M HUMPHREY	AMERICAN	10	47.7 N	85.2 W	18	08	M 42	2 NM	26		- 2.0	8.0	6	5			
ROBERT C STANLEY	AMERICAN	10	47.2 N	91.0 W	12	04	M 44	10 NM	50		3.0			6.5			
ROBERT C STANLEY	AMERICAN	11	48.2 N	88.8 W	00	01	M 43	2 NM	26		- 1.0			6.5			
JOHN DYKSTRA	AMERICAN	13	47.4 N	87.1 W	18	17	M 44	10 NM	02		5.0	5.0	6	10			
PHILIP R CLARKE	AMERICAN	14	45.3 N	86.6 W	06	26	M 43	10 NM	03		4.0	15.0	6	10			
HERBERT C JACKSON	AMERICAN	14	45.9 N	84.2 W	18	27	M 50	10 NM	02		3.0	8.0	3	6.5			
SAMUEL MATHER	AMERICAN	14	46.8 N	86.1 W	06	24	M 44	10 NM	03		5.0	8.0	7	8			
CASON J CALLAWAY	AMERICAN	14	45.0 N	87.0 W	06	26	M 47	5 NM	01		3.0	11.0		10			
WILLIAM CLAY FORD	AMERICAN	14	47.3 N	88.8 W	00	27	M 46	10 NM	02		7.0	8.0	XX	8			
THOMAS WILSON	AMERICAN	17	44.8 N	82.9 W	18	21	M 44	5 NM	02		16.0	11.0	4	6			
SEWELL AVERY	AMERICAN	18	44.2 N	83.6 W	06	24	M 42	> 25 NM	02		6.0	9.0		11.5			
MYRON C TAYLOR	AMERICAN	18	41.9 N	83.0 W	00	25	M 45	10 NM	03		8.0	7.0		5			
JOHN G MUNSON	AMERICAN	18	42.7 N	87.5 W	00	26	M 48	10 NM	00		3.0	8.0		11.5			
J A W IGLEHART	AMERICAN	18	47.1 N	85.0 W	00	35	M 42	1 NM	22		1.0	7.0	5	10			
J BURTON AYERS	AMERICAN	18	41.8 N	83.2 W	06	24	M 45	5 NM	02		3.0	13.0					
ARTHUR M ANDERSON	AMERICAN	18	42.9 N	87.0 W	00	25	M 45	5 NM	02		2.0	9.0		14.5			
WILLIAM A REISS	AMERICAN	19	45.4 N	83.3 W	06	27	M 45	10 NM	70		3.0	7.0	3	5			
PHILIP R CLARKE	AMERICAN	28	41.9 N	81.0 W	18	26	M 45	2 NM	70		1.0	6.0	6	8			
J L MAUTHE	AMERICAN	30	45.6 N	83.9 W	06	29	M 42	10 NM	70		0.0	6.0	5	8			
ROBERT C STANLEY	AMERICAN	30	46.9 N	87.0 W	00	29	M 44	5 NM	02		- 2.0			8			
HERBERT C JACKSON	AMERICAN	30	43.8 N	87.5 W	06	31	M 42	10 NM	70		- 7.0	6.0	3	5			
RALPH H WATSON	AMERICAN	30	44.4 N	83.0 W	00	22	M 46	10 NM	03		3.0	7.0	9	8			
NORTH ATLANTIC OCEAN		DEC.															
FALSTRIA	DANISH	2	40.5 N	21.5 W	12	25	M 42	5 NM	82	1006.5	16.6	18.0	8	19.5			
AMER LEGACY	AMERICAN	2	46.4 N	34.1 W	06	32	45	10 NM	18	995.8	10.0	15.0	5	6.5	32	< 6	13
EXPORT AMBASSADOR	AMERICAN	3	45.6 N	51.1 W	12	30	50	5 NM	18	997.0	4.0	9.0	4	10			
AMER LEGACY	AMERICAN	3	44.3 N	47.5 W	18	27	41	5 NM	02	996.5	4.4	10.0	5	8	27	< 6	13
AMER RACER	AMERICAN	4	47.6 N	14.3 W	18	16	45	5 NM	15	999.5	11.7	12.2	9	14.5	30	9	8
SEALAND PRODUCER	AMERICAN	5	47.6 N	08.2 W	12	18	65	2 NM	02	1009.1	13.0	11.0	8	13	18	< 6	16.5
ORIENTAL EDUCATOR	BRITISH	5	31.7 N	79.1 W	12	23	45	10 NM	01	1005.8	23.4	20.0	5	8			
ROBERTS BANK	LIBERIAN	6	46.0 N	10.0 W	18	20	M 55	10 NM	02	992.5	15.0	15.0	4	10	26	7	16.5
EXXON JAMESTOWN	AMERICAN	6	35.2 N	74.6 W	06	35	45	5 NM	07	1011.0	20.0	25.0					
ROBERTS BANK	LIBERIAN	7	44.9 N	12.0 W	12	23	M 55	5 NM	16	986.4	16.0	16.0	10	23	27	8	32.5
EXPORT LEADER	AMERICAN	7	47.3 N	15.1 W	12	25	45	5 NM	64	972.0	10.0	13.4	5	10			
AMER ACE	AMERICAN	8	46.2 N	25.1 W	12	25	44	5 NM	25	980.0	12.2	13.9	4	16.5	26	9	26
ROBERTS BANK	LIBERIAN	8	43.0 N	14.5 W	12	24	M 44	10 NM	62	997.5	16.0	16.0	5	10	24	7	24.5
SEALAND PRODUCER	AMERICAN	8	36.3 N	24.6 W	18	26	45	10 NM	01	1000.3	17.5	14.5	5	8	26	9	13
SEALAND RESOURCE	AMERICAN	8	45.4 N	16.9 W	12	24	41	10 NM	15	990.9	13.2	12.2	5	13	27	>13	24.5
LIGHTNING	AMERICAN	8	35.9 N	37.2 W	18	28	45	10 NM	02	1001.4	20.0	19.5	4	6.5	30	X	13
SEALAND GALLOWAY	AMERICAN	9	35.9 N	20.1 W	12	22	45	2 NM	64	1003.0	18.8	16.7	7	11.5	30	11	19.5
EDGAR M QUEENY	AMERICAN	9	32.2 N	79.1 W	19	23	50	10 NM	02	1007.0	25.6	23.5	4	8	18	8	14.5
LIGHTNING	AMERICAN	9	35.9 N	38.9 W	00	28	45	5 NM	26	1005.1	14.4	20.0	4	8	30	X	14.5
ANTONIA JOHNSON	SWEDISH	10	40.1 N	18.5 W	16	22	60	.25 NM	63	987.2	17.8	17.2	12	13	22	>13	32.5
AMER ARCHER	AMERICAN	10	46.1 N	23.4 W	12	12	45	2 NM	65	965.0	10.6	14.4	6	5	12	< 6	21
AMER ACE	AMERICAN	10	44.4 N	39.8 W	12	31	46	5 NM	02	994.9	6.7	13.5	6	6	30	8	29.5
AMER ARGOSY	AMERICAN	10	45.5 N	23.9 W	12	18	50	5 NM	63	963.0	10.0	14.4	5	8	13	< 6	11.5
SEALAND ECONOMY	AMERICAN	10	42.6 N	14.8 W	18	20	47	1 NM	07	980.0	14.0	16.7	9	23			
ROBERTS BANK	LIBERIAN	10	39.6 N	22.0 W	12	22	M 78	1 NM	61	986.0	17.5	17.0	4	19.5	23	6	41
SEALAND GALLOWAY	AMERICAN	10	35.9 N	32.1 W	12	27	45	5 NM	01	1004.5	19.4	18.9	7	13	27	12	21
EXXON JAMESTOWN	AMERICAN	10	38.0 N	73.0 W	06	32	45	5 NM	07	1017.0	8.0	14.0	3	6.5	32	< 6	10
HOEGH MALLARD	NORWEGIAN	10	43.2 N	18.3 W	12	17	M 47	1 NM	63	984.5	13.0		8	13	28	10	10
OCEANIC	PANAMANIAN	10	36.0 N	72.4 W	06	29	M 48	5 NM	25	1004.0	15.0	26.7	6	13			
LIGHTNING	AMERICAN	10	35.5 N	49.5 W	18	25	45	10 NM	02	1010.5	20.0	21.0	3	6.5	27	8	14.5
ANTONIA JOHNSON	SWEDISH	11	39.6 N	18.8 W	00	24	50	2 NM	01	996.0	15.5	16.9	10	10	24	>13	32.5
AMER ACE	AMERICAN	11	44.1 N	45.2 W	06	26	58	5 NM	02	992.9	5.6	7.8			26	8	29.5
SUECIA	SWEDISH	11	44.2 N	14.3 W	12	28	56	10 NM	02	985.2	13.3	14.0	9	14.5	26	11	19.5
ROBERTS BANK	LIBERIAN	11	39.5 N	22.3 W	00	29	M 64	1 NM	62	996.5	14.0	17.0	3	19.5	27	6	46
EXPORT PATRIOT	AMERICAN	11	46.0 N	33.1 W	18	27	55	2 NM	25	985.0	12.0	13.9	10	29.5			
EXPORT LEADER	AMERICAN	11	45.6 N	41.5 W	18	28	50	200 YD	86	994.2	3.3	14.5	6	14.5	28	6	29.5
HOEGH MALLARD	NORWEGIAN	11	45.7 N	11.3 W	12	30	M 55	1 NM	80	979.0	14.0		10	24.5			
AMER LEADER	AMERICAN	12	49.7 N	07.6 W	18	27	45	.5 NM		975.2	12.3	11.0	8	11.5	26	>13	19.5
AMER ACE	AMERICAN	12	43.9 N	48.8 W	00	27	50	10 NM	26	1008.5	0.4	1.2			26	8	29.5
ROBERTS BANK	LIBERIAN	12	37.8 N	29.4 W	18	26	M 45	10 NM	02	1014.5	17.0	17.0	3	11.5	28	7	19.5
SUECIA	SWEDISH	12	43.1 N	16.4 W	12	27	55	10 NM	02	1003.4	14.1	14.0	9	14.5	28	12	29.5
EXPORT PATRIOT	AMERICAN	12	46.6 N	30.5 W	00	23	55	2 NM	15	986.0	7.0	13.9	10	39			
EXPORT LEADER	AMERICAN	12	45.5 N	42.4 W	00	28	50	5 NM	85	994.5	2.2	14.5					
ROBERTS BANK	LIBERIAN	13	37.6 N	31.2 W	06	27	M 42	10 NM	91	1016.9	17.5	17.0	5	6.5	31	7	14.5
EXPORT PATRIOT	AMERICAN	13	48.6 N	16.2 W	06	26	45	5 NM	15	980.0	11.0	13.3	8	29.5			
EXPORT COURIER	AMERICAN	13	35.0 N	51.9 W	18	19	45	5 NM	50	1006.1	21.0	20.0	3	10	XX	6	16.5

Vessel	Nationality	Date	Position of Ship Lat. deg.	Long. deg.	Time GMT	Wind Dir. 10°	Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C. Air	Sea	Sea Waves+ Period sec.	Height ft.	Swell Waves Dir. 10°	Period sec.	Height ft.
NORTH ATLANTIC OCEAN		DEC.															
ROBERTS BANK	LIBERIAN	14	36.7 N	37.9 W	12	21	M 50	2 NM	02	1013.0	21.0	17.0	4	8	21	7	19.5
EXPORT COURIER	AMERICAN	15	37.4 N	62.6 W	00	29	45	5 NM	29	1011.5	17.0	21.7	3	10	28	6	14.5
GLOMAR PACIFIC	AMERICAN	17	39.3 N	72.6 W	17	30	M 45	10 NM	01	1007.8	6.7	13.9	7	24.5			
ROBERTS BANK	LIBERIAN	18	36.7 N	63.1 W	00	22	M 46	2 NM	65	997.5	18.0	21.0	6	8	22	7	16.5
AMER LEGEND	AMERICAN	18	51.0 N	32.9 W	00	29	50	5 NM	62	1012.2	6.1	10.0	15	26			
YOUNG AMERICA	AMERICAN	18	36.3 N	65.0 W	18	34	50	1 NM	18	1006.0	11.2	17.7	5	16.5	34	< 6	29.5
EXXON HOUSTON	AMERICAN	18	41.2 N	69.3 W	18	29	45	10 NM	02	1001.7	4.5	6.6	5	10			
COLORADO	AMERICAN	18	37.2 N	74.3 W	00	32	45	10 NM	03	1017.2	4.4	15.0	9	16.5			
JACKSONVILLE	AMERICAN	18	36.3 N	72.2 W	00	32	41	5 NM	02	1013.2	11.6	25.0	5	11.5	30	10	14.5
GLOMAR PACIFIC	AMERICAN	18	39.3 N	72.6 W	17	33	M 45	10 NM	07	986.5	3.9	13.9	8	23	29	7	10
LASH ITALIA	AMERICAN	18	35.0 N	57.4 W	18	23	58	5 NM	60	999.0	13.9	20.0	9	10	29	9	14.5
LASH PACIFICO	AMERICAN	18	34.6 N	61.5 W	06	27	M 55	2 NM	92	1000.3	20.0	22.0	5	6.5			
ROBERTS BANK	LIBERIAN	19	35.8 N	66.8 W	18	30	M 50	10 NM	02	1004.8	16.5	22.0	6	8	30	6	14.5
LASH PACIFICO	AMERICAN	19	33.1 N	68.4 W	06	29	M 45	10 NM	15	1015.2	15.5	21.0	4	11.5	28	>13	23
ROBERTS BANK	LIBERIAN	20	35.8 N	67.4 W	00	32	M 49	10 NM	02	1007.5	13.0	22.0	5	8	30	6	14.5
MORMACRIGEL	AMERICAN	21	36.5 N	69.3 W	18	23	45	5 NM	07	997.6	22.3	21.6	7	8	25	< 6	14.5
CHOAPA	CHILEAN	23	36.3 N	26.6 W	19	24	45	2 NM	02	1006.5	18.8	16.0	7	13	28	9	13
EXPORT PATRIOT	AMERICAN	23	45.5 N	16.0 W	12	26	55	2 NM	62	983.0	12.0	10.0	11	41			
SNOW LAND	SWEDISH	24	43.7 N	39.8 W	00	27	50	5 NM	02	996.5	7.8				27	10	23
EXPORT PATRIOT	AMERICAN	24	44.7 N	18.7 W	00	27	45	5 NM	02	986.8	14.5	13.9					
SNOW LAND	SWEDISH	25	40.2 N	44.2 W	12	30	56	5 NM	02	1001.0	8.5		10	36			
RIGOLETTO	SWEDISH	25	49.1 N	24.7 W	00	27	M 55	5 NM	62	982.8	10.2	14.0	10	13	27	X	26
AMER CHALLENGER	AMERICAN	25	38.8 N	70.2 W	18	27	47	5 NM	02	999.5	11.1	16.1	4	11.5	26	8	16.5
ARCO PRESTIGE	AMERICAN	25	36.7 N	72.0 W	18	26	45	2 NM	14	997.0	10.5	11.7	7	14.5	29	12	29.5
TRINITY	AMERICAN	25	33.8 N	78.5 W	00	23	45	10 NM	01	999.9	22.0	25.0	8	14.5			
EXXON JAMESTOWN	AMERICAN	25	39.2 N	71.9 W	18	26	60	5 NM	03	996.0	10.5	12.8			26	7	26
CHOAPA	CHILEAN	25	36.3 N	39.8 W	19	29	47	2 NM	16	1003.4	14.4	17.0	6	19.5	30	12	19.5
MOBIL GAS	AMERICAN	25	35.7 N	72.7 W	06	27	44	5 NM	81	994.6	21.7	25.6	5	8	XX	6	10
ZIM TOKYO	GERMAN	26	36.0 N	23.5 W	18	27	44	5 NM	03	999.0	16.0	17.2	8	28			
AMER ARCHER	AMERICAN	26	43.2 N	65.2 W	12	27	55	2 NM	02	992.0	1.7	4.4	11	29.5	17	10	18
AMER CHALLENGER	AMERICAN	26	39.1 N	70.8 W	00	27	50	5 NM	02	1002.0	9.4	16.1	4	10	26	10	19.5
CHOAPA	CHILEAN	27	36.2 N	46.0 W	10	28	60	2 NM	02	1003.5	18.0	16.0	6	16.5	27	12	16.5
EXPORT PATRIOT	AMERICAN	27	40.2 N	40.0 W	14	28	60	5 NM	18	994.6	14.5	17.2	11	42.5			
RED JACKET	AMERICAN	27	36.1 N	21.1 W	06	28	45	10 NM	01	1008.5	15.7	15.7	5	19.5			
UNIMAK	AMERICAN	28	39.2 N	61.8 W	18	29	M 45	5 NM	82	1007.5	5.5	14.0	8	24.5	25	8	19.5
SNOW LAND	SWEDISH	28	39.7 N	58.9 W	12	27	50	5 NM	89	1000.0	8.0		10	26			
SEALAND MARKET	AMERICAN	28	36.5 N	51.8 W	18	28	60	5 NM	03	1005.0	12.3	18.8					
ROBERTS BANK	LIBERIAN	29	27.2 N	74.7 W	12	07	M 50	5 NM	07	1016.5	21.0	23.0	2	10	08	12	16.5
RED JACKET	AMERICAN	29	37.5 N	42.0 W	18	28	45	10 NM	18	1001.7	16.2	16.7	6	29.5			
ZIM TOKYO	GERMAN	29	38.3 N	42.6 W	18	28	44	5 NM	03	1001.0	13.0	16.7		19.5			
EXPORT FREEDOM	AMERICAN	29	36.7 N	55.6 W	00	28	30	5 NM	81	1005.1	11.1	19.4	3	10	29	9	34.5
EXPORT PATRIOT	AMERICAN	29	41.6 N	40.5 W	12	27	50	10 NM	02	986.5	14.0	16.7	8	36			
ROBERTS BANK	LIBERIAN	30	24.5 N	74.8 W	00	07	M 42	5 NM	02	1016.0	24.5	23.0	3	8			
EXPORT PATRIOT	AMERICAN	30	42.3 N	40.4 W	00	29	50	10 NM	02	992.0	13.0	17.2	8	36			
ANNIE JOHNSON	SWEDISH	31	46.8 N	13.1 W	18	36	52	10 NM	02	1006.5	8.8	12.8	8	29.5	24	>13	23
CHALLENGER	LIBERIAN	31	46.3 N	13.7 W	18	28	41	5 NM	03	1010.0	12.5	12.0	9	16.5			
GREAT LAKES VESSELS																	
BENJAMIN F FAIRLESS	AMERICAN	4	44.5 N	83.1 W	18	25	M 44	10 NM	02		- 1.0	6.0	4	8			
HOMER D WILLIAMS	AMERICAN	4	47.3 N	89.9 W	18	23	M 45	2 NM	71		- 4.0	2.0		14.5			
WILLIAM CLAY FORD	AMERICAN	4	43.5 N	82.5 W	18	23	M 42	10 NM	70		- 3.0	6.0		5			
HOMER D WILLIAMS	AMERICAN	5	47.1 N	90.9 W	00	24	M 44	10 NM	02		- 3.0	1.0		8			
CHARLES M BEEGHLY	AMERICAN	5	45.6 N	87.0 W	00	24	M 55	2 NM	71		-10.0	3.0	2	13			
J BURTON AYERS	AMERICAN	5	44.9 N	80.7 W	12	25	M 44	10 NM	70		- 1.0	7.0	3	5			
THOMAS WILSON	AMERICAN	13	45.6 N	83.7 W	18	31	M 45	2 NM	85		- 1.0	8.0	6	11.5			
ROBERT C STANLEY	AMERICAN	14	45.4 N	83.8 W	00	29	M 50	10 NM	02		- 3.0			6.5			
CRISPIN OGLEBAY	AMERICAN	14	41.8 N	82.3 W	18	23	M 41	10 NM	02		- 2.0	4.0	3	10			
HERBERT C JACKSON	AMERICAN	14	45.3 N	83.3 W	00	31	M 43	5 NM	02		- 3.0	4.0	6	10			
A H FERBERT	AMERICAN	15	47.5 N	88.9 W	18	27	M 42	10 NM	03		1.0	4.0	4	6.5			
G M HUMPHREY	AMERICAN	17	45.5 N	83.5 W	12	32	M 42	10 NM	68		- 2.0	8.0	4	13			
CHARLES M BEEGHLY	AMERICAN	17	44.9 N	83.1 W	12	30	M 43	10 NM	70		- 4.0	5.0	2	10			
HERBERT C JACKSON	AMERICAN	17	44.9 N	83.0 W	06	30	M 50	10 NM	02		2.0	4.0	3	5			
IRVING S OLDS	AMERICAN	23	44.3 N	83.0 W	00	25	M 43	10 NM	02		1.0	5.0	6	10			
BENJAMIN F FAIRLESS	AMERICAN	23	47.5 N	87.9 W	00	29	M 44	10 NM	02		- 3.0	3.0	7	10			
ENVIRONMENTAL BUOYS																	
44004	AMERICAN	18	39.0 N	70.0 W	12	31	M 44			1008.7	4.9	15.7	10	23			
44005	AMERICAN	18	42.7 N	68.3 W	21	30	M 45			995.3	-0.9						
44005	AMERICAN	26	42.7 N	68.3 W	00	27	M 45			985.8	4.3		9	18			

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest windspeed was selected.

Continued from page 200.

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DECEMBER                     D A T A     S U M M A R Y                          42004
        AVERAGE LATITUDE  27.5N                   AVERAGE LONGITUDE  085.5W
--------------------------------------------------------------------------------------
MEANS AND EXTREMES                      !          !                      ! NO. OF !  DAYS WITH
                          MIN    (DA HR) !     MEAN !    MAX    (DA HR)   !  OBS   !    DATA
   AIR  TEMP (DEG C)     14.6    (27 21) !     18.7 !    24.3   (24 15)   !   52   !     8
   PRESSURE  (MBAR)    1007.7    (24 21) !   1017.8 !  1024.3   (31 15)   !   52   !     8
--------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
        ^------- SPEED   (KNOTS)-------------^-------^ MEAN
   -----!          4-    11-    22-    34-         ! TOTAL ! SPEED      NO. OF OBS:    52
    DIR !   <4     10     21     33     47   >47   !   %   !(KNOTS)
   -----!                                          !       !
    N   !          5.8                             !   5.8 !  6.7         MAX WIND
    NE  !         11.5   18.2                      !  30.8 ! 13.1     SPEED:   22 KNOTS
    E   !         13.5   26.9    1.9               !  42.3 ! 13.5     DIRECTION: 080 DEG
    SE  !                 5.8                      !   5.8 ! 14.0     DAY:      20
    S   !                 1.9                      !   1.9 ! 15.0     HOUR:     00
    SW  !                 3.8                      !   3.8 ! 17.0
    W   !                 5.8                      !   5.8 ! 14.4
    NW  !                 3.8                      !   3.8 ! 12.0
   CALM !                                          !       !
  TOTAL !         30.8   67.3    1.9               ! 100.0 ! 13.2
--------------------------------------------------------------------------------------
DECEMBER                     D A T A     S U M M A R Y                          42005
        AVERAGE LATITUDE  30.0N                   AVERAGE LONGITUDE  085.9W
--------------------------------------------------------------------------------------
MEANS AND EXTREMES                      !          !                      ! NO. OF !  DAYS WITH
                          MIN    (DA HR) !     MEAN !    MAX    (DA HR)   !  OBS   !    DATA
   AIR  TEMP (DEG C)     07.5    (25 15) !     14.8 !    21.8   (21 12)   !  146   !    19
   SEA  TEMP (DEG C)     17.1    (30 12) !     18.8 !    20.1   (14 15)   !  146   !    19
 AIR-SEA TEMP (DEG C)   -11.2    (14 15) !    -04.2 !    02.0   (20 12)   !  146   !    19
   PRESSURE  (MBAR)    1003.8    (24 12) !   1020.8 !  1031.1   (13 15)   !  146   !    19
--------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
        ^------- SPEED   (KNOTS)-------------^-------^ MEAN
   -----!          4-    11-    22-    34-         ! TOTAL ! SPEED      NO. OF OBS:   146
    DIR !   <4     10     21     33     47   >47   !   %   !(KNOTS)
   -----!                                          !       !
    N   !  2.1    4.8   16.4                       !  23.3 ! 13.3         MAX WIND
    NE  !         5.5   19.2                       !  24.7 ! 14.3     SPEED:   22 KNOTS
    E   !   .7    5.5   17.1                       !  23.3 ! 12.8     DIRECTION: 280 DEG
    SE  !   .7    1.4     .7                       !   2.7 !  7.8     DAY:      25
    S   !         5.5    4.1                       !   9.6 ! 11.0     HOUR:     00
    SW  !         4.8    2.7                       !   7.5 !  9.7
    W   !   .7    1.4     .7    1.4                !   4.1 ! 11.4
    NW  !   .7    1.4    2.7                       !   4.8 ! 12.9
   CALM !                                          !       !
  TOTAL !  4.8   30.1   63.7    1.4                ! 100.0 ! 12.7
--------------------------------------------------------------------------------------
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DECEMBER                     D A T A     S U M M A R Y                          44005
        AVERAGE LATITUDE  42.7N                   AVERAGE LONGITUDE  068.3W
--------------------------------------------------------------------------------------
MEANS AND EXTREMES                      !          !                      ! NO. OF !  DAYS WITH
                          MIN    (DA HR) !     MEAN !    MAX    (DA HR)   !  OBS   !    DATA
   AIR  TEMP (DEG C)    -06.2    (18 15) !     02.1 !    08.1   (17 12)   !  124   !    16
   PRESSURE  (MBAR)    0981.8    (21 18) !   1010.4 !  1037.5   (31 15)   !  124   !    16
--------------------------------------------------------------------------------------
WIND - % FREQUENCIES, MEANS AND EXTREMES
        ^------- SPEED   (KNOTS)-------------^-------^ MEAN
   -----!          4-    11-    22-    34-         ! TOTAL ! SPEED      NO. OF OBS:   124
    DIR !   <4     10     21     33     47   >47   !   %   !(KNOTS)
   -----!                                          !       !
    N   !   .8    2.4    9.7                       !  12.9 ! 14.1         MAX WIND
    NE  !         1.6                              !   1.6 !  6.0     SPEED:   45 KNOTS
    E   !  1.6            .8     .8     .8         !   4.0 ! 17.4     DIRECTION: 270 DEG
    SE  !          .8    1.6    2.4                !   4.8 ! 20.3     DAY:      26
    S   !          .8    4.0     .8                !   5.6 ! 15.7     HOUR:     00
    SW  !         3.2     .8     .8     .8         !   5.6 ! 15.1
    W   !   .8    2.4    8.7   16.1   10.5         !  38.5 ! 26.1
    NW  !                8.1   14.5    3.2         !  25.8 ! 26.2
   CALM !                                          !       !
  TOTAL !  3.2   11.3   34.7   35.5   15.3         ! 100.0 ! 22.4
--------------------------------------------------------------------------------------
WAVES - % FREQUENCIES, MEAN AND EXTREME   (METERS)               NO. OF WAVE  OBS:    123
HEIGHT  (M)   <1   1-1.5 2-2.5 3-3.5 4-5.5 6-7.5 8-9.5  >9.5 !  MEAN    MAX   (DA HR)
% FREQUENCY   9.8  35.8  17.1  19.5  17.8                    !  2.3M    5.5M  (28 03)
--------------------------------------------------------------------------------------
% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING  MODERATE: 0.0%  SEVERE: NONE  #OBS:    124
```

Table 8
Selected Gale and Wave Observations, North Pacific

November and December 1978

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves†: Period sec.	Sea Waves†: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH PACIFIC OCEAN		NOV.															
AMER LIBERTY	AMERICAN	1	24.7 N	120.2 E	06	05	46	5 NM	01	1015.8	22.3	23.3	8	10			
TUNAMI MARU	JAPANESE	1	50.5 N	135.9 W	18	21	45	1 NM	25	993.0	13.2	13.0	6	16.5	22	12	23
GLACIER BAY	AMERICAN	1	41.5 N	152.4 W	06	34	45	2 NM	62	1006.9	11.7	13.4	4	11.5	31	9	13
PACIFIC VENTURE	PANAMANIAN	2	52.2 N	174.3 E	18	18	M 44	1 NM	10	994.0	8.0	6.5	4	26			
THOMAS WASHINGTON	AMERICAN	2	18.3 N	146.9 E	06	13	M 46	.5 NM	65	995.6	26.7	30.0	5	10	14	7	24.5
B T ALASKA	AMERICAN	2	53.9 N	138.0 W	00	25	55	5 NM	21	987.5	7.5	10.0	7	16.5			
BOUTWELL	AMERICAN	3	54.2 N	164.4 W	15	20	M 41	.5 NM	53	993.2	6.3	6.7		14.5			
RUSH	AMERICAN	3	54.6 N	159.0 W	21	21	M 41	1 NM	62	993.1	8.6	8.7	8	19.5			
PRES KENNEDY	AMERICAN	3	36.7 N	144.3 W	18	36	45	5 NM	65	1015.9	14.4	17.8	6	18	02	8	24.5
PACIFIC VENTURE	PANAMANIAN	3	51.3 N	170.0 E	06	27	M 48	2 NM	03	999.5	6.0	6.0	4	23			
THOMAS WASHINGTON	AMERICAN	3	16.6 N	146.9 E	06	18	M 50	.25 NM	65	995.6	26.7	30.0	5	10	18	7	29.5
VAN WARRIOR	LIBERIAN	3	49.6 N	164.4 W	18	21	45	.5 NM	53	1010.0	9.0	9.0					
EXXON NEW ORLEANS	AMERICAN	4	50.8 N	145.1 W	18	10	45	5 NM	62	994.9	7.5	9.5	XX	6.5	12	< 6	10
PORTLAND	AMERICAN	4	56.8 N	147.9 W	12	25	45	10 NM	02	996.3	5.6	4.4	6	13	25	7	23
SHUNWIND	LIBERIAN	5	50.6 N	136.5 W	18	21	M 42	10 NM	03	1006.0	9.0	18.0	4	6.5	24	11	14.5
MOBIL ARCTIC	AMERICAN	5	59.2 N	144.5 W	18	10	50	5 NM	60	970.8	6.5	7.7	5	13	10	6	19.5
EXXON NEW ORLEANS	AMERICAN	5	55.0 N	143.9 W	21	23	55	5 NM	21	997.8	9.5	8.7	XX	19.5	23	6	29.5
MEDITERRANEAN CARRIER	BRITISH	6	34.2 N	163.2 E	20	19	50	2 NM	63	995.0	24.0				19	>13	29.5
EXXON NEW ORLEANS	AMERICAN	6	55.0 N	143.8 W	06	23	54	10 NM	64	984.1	9.0	7.3	XX	19.5	23	7	29.5
WESTWARD VENTURE	AMERICAN	6	54.1 N	136.3 W	00	21	M 42	2 NM	81	991.5	7.8	10.0	5	8	23	6	13
ARCO FAIRBANKS	AMERICAN	6	59.5 N	145.0 W	12	24	M 50	5 NM	61	965.8	6.0	9.5	8	19.5			
B T ALASKA	AMERICAN	6	58.5 N	143.9 W	12	22	45	2 NM	01	997.5	6.7	8.0	6	11.5	11	13	13
BOUTWELL	AMERICAN	6	56.5 N	155.7 W	06	30	M 54	5 NM	25	983.1	2.8	7.2					
PORTLAND	AMERICAN	6	54.3 N	133.0 W	00	23	45	1 NM	10	997.0	9.4	10.0	5	10	23	7	19.5
PHILADELPHIA	AMERICAN	7	42.7 N	172.0 E	18	29	65	.5 NM	61	975.3	10.6	10.6	6	13	26	13	34.5
ARCO DUKE	BRITISH	7	38.9 N	153.8 W	18	03	45	5 NM	63	1008.5	12.8	15.0	8	19.5			
BOUTWELL	AMERICAN	7	56.2 N	152.5 W	06	30	M 43	5 NM	03	994.7	1.8	6.7					
PRES JEFFERSON	AMERICAN	7	32.8 N	166.5 E	00	18	42	5 NM	03	1004.6	24.4	22.2	5	6.5			
SVENDBORG MAERSK	DANISH	7	41.4 N	172.8 E	18	28	64	.25 NM	65	992.0	12.0		4	23			
SEALAND EXCHANGE	AMERICAN	7	38.5 N	156.1 W	12	07	45	2 NM	07	1011.5	10.6	15.6					
MEDITERRANEAN CARRIER	BRITISH	7	34.6 N	163.2 E	00	27	60	2 NM	07	1000.0	20.6						
CALIFORNIA RAINBOW	JAPANESE	7	40.9 N	179.4 W	18	18	M 42	2 NM	81	989.0	16.0	16.0	5	8	17	7	10
PHILADELPHIA	AMERICAN	8	42.5 N	174.8 E	00	27	55	.5 NM		995.5	9.5	10.0	8	19.5	28	10	34.5
SANTA CLARA	AMERICAN	8	57.3 N	147.7 W	00	31	42	10 NM	01	1005.4	5.5	4.4	6	8	31	12	19.5
SVENDBORG MAERSK	DANISH	8	40.7 N	173.3 E	00	28	60	2 NM	02	1005.3	13.0		5	24.5			
SONGKHLA	DANISH	8	43.0 N	174.7 W	00	18	M 47	2 NM	51	1001.5	13.6	13.0	8	16.5			
PACIFIC WING	PANAMANIAN	9	38.4 N	150.1 E	18	32	M 41	5 NM	21	1011.0	11.0	11.0	6	18			
HAWAIIAN CITIZEN	AMERICAN	9	37.4 N	123.7 W	18	35	45	10 NM	02	1011.9	13.9	13.9	8	6.5	35	13	16.5
PACIFIC WING	PANAMANIAN	10	36.4 N	152.4 E	00	31	M 42	5 NM	15	1014.0	13.0	12.0	9	23			
ATLANTIC PIONEER	PANAMANIAN	10	44.1 N	158.6 E	06	34	M 45	1 NM	07	1003.2	8.0	11.0	2	10	35	< 6	24.5
ARCO ANCHORAGE	AMERICAN	10	37.7 N	125.0 W	06	33	M 47	5 NM	02	1009.1	11.2	11.2	4	11.5	34	9	19.5
ORIENTAL EDUCATOR	BRITISH	10	37.7 N	164.0 E	06	27	M 50	10 NM	03	1006.8	19.2	16.0	4	5	19	8	8
HAWAIIAN QUEEN	AMERICAN	10	35.8 N	128.6 W	18	02	45	10 NM	03.	1015.9	13.3	18.9	5	10	05	6	18
HAWAIIAN CITIZEN	AMERICAN	10	37.0 N	125.4 W	00	36	45	10 NM	01	1012.1	17.8	13.3	8	6.5	36	13	16.5
PORTLAND	AMERICAN	11	55.7 N	142.1 W	12	31	60	10 NM	01	1013.2	5.0	6.7	5	19.5	31	7	26
CHEVRON ARIZONA	AMERICAN	11	39.9 N	125.0 W	00	36	M 45	10 NM	02	1007.5	12.2		8	16.5	36	8	23
ARCO JUNEAU	AMERICAN	11	55.5 N	137.8 W	00	14	M 50	2 NM	82	1018.2	8.0	3.5			15	>13	18
ARCO ANCHORAGE	AMERICAN	11	40.4 N	128.0 W	06	35	M 50	5 NM	03	1014.1	9.5	11.2					
ARCO FAIRBANKS	AMERICAN	11	39.6 N	125.6 W	00	36	M 50	10 NM	02	1000.8	10.0	11.7	9	18			
SEALAND COMMERCE	AMERICAN	11	38.0 N	127.0 W	18	36	45	5 NM	02	1009.2	8.3	12.8	5	10	36	7	13
OVERSEAS NEW YORK	AMERICAN	11	41.2 N	126.7 W	06	04	45	10 NM	02	1016.5	7.8	12.3	8	14.5			
MANHATTAN	AMERICAN	11	57.2 N	142.9 W	00	13	50	5 NM	63	1005.0	5.0	7.2			14	7	13
MATSONIA	AMERICAN	11	36.0 N	125.2 W	18	34	45	5 NM	03	1008.0	9.4	11.1	3	10			
PRESIDENT MADISON	AMERICAN	12	35.9 N	166.8 E	18	30	M 50	10 NM	02	1007.0	17.2	18.3	7	10	30	9	13
ATLANTIC PIONEER	PANAMANIAN	12	47.7 N	172.8 E	18	17	M 45	5 NM	81	988.7	9.0	7.0	2	6.5	18	6	19.5
ARNOLD MAERSK	DANISH	12	37.9 N	163.3 E	18	27	41	10 NM	25	1009.4	10.0						
MANHATTAN	AMERICAN	12	53.4 N	136.3 W	00	36	45	5 NM	60	1017.3	12.8	8.9	3	5	34	9	16.5
FRIENDSHIP	LIBERIAN	12	34.6 N	159.1 E	06	29	M 45	2 NM	03	1007.0	18.0	24.0	7	10			
PRESIDENT MADISON	AMERICAN	13	35.5 N	165.1 E	00	30	M 55	10 NM	01	1015.0	18.3	17.2	7	10	30	12	24.5
PRES PIERCE	AMERICAN	13	42.5 N	171.3 E	06	25	47	10 NM	03	998.5	7.8	10.6	9	19.5			
PACIFIC VENTURE	PANAMANIAN	13	41.2 N	168.6 E	00	27	M 45	2 NM	80	1002.6	9.0	11.5			27	12	24.5
ATLANTIC PIONEER	PANAMANIAN	13	48.4 N	172.8 E	00	17	M 55	1 NM	07	969.2	8.0	6.0	2	10	17	8	34.5
GLADIOLUS	LIBERIAN	13	54.0 N	178.2 E	06	14	M 50	5 NM	02	998.5	5.5	4.0	6	13	14	8	16.5
SEALAND TRADE	AMERICAN	14	42.3 N	169.0 E	00	28	43	10 NM	16	1006.7	5.0	10.0	6	16.5			
JAPAN RAINBOW	JAPANESE	14	52.1 N	172.3 W	00	14	M 42	1 NM	83	1010.0	4.0	5.0	6	8			
GLADIOLUS	LIBERIAN	14	53.6 N	174.5 E	06	14	M 44	5 NM	03	982.5	6.0	4.0	6	13	14	8	19.5
CHEVRON WASHINGTON	AMERICAN	15	46.3 N	130.4 W	12	17	M 42	5 NM	25	1002.0	10.6		3	6.5	17	< 6	13
EXPORT CHALLENGER	AMERICAN	15	36.2 N	177.5 W	18	34	45	5 NM	01	997.6	15.0	20.0	3	10	34	12	19.5
PACIFIC ACE	PANAMANIAN	16	34.8 N	162.1 E	18	30	M 47	10 NM	02	1008.0	17.5	24.0	7	8			
PRES ROOSEVELT	AMERICAN	16	37.5 N	167.9 W	06	21	60	2 NM	07	991.1	17.3	18.3	7	29.5			
HONSHU GLORIA	LIBERIAN	16	36.9 N	169.0 W	06	32	M 69	2 NM	63	997.0	5.5	12.0	6	24.5	28	7	24.5
PACIFIC VENTURE	PANAMANIAN	17	44.7 N	158.1 W	06	32	M 48	2 NM	50	997.0	8.0	10.0			32	>13	24.5
YAMASHIN MARU	JAPANESE	17	42.6 N	153.5 W	09	27	M 42	2 NM	01	1009.5	11.0	12.5	9	13	27	11	19.5
SEALAND COMMERCE	AMERICAN	17	34.6 N	168.4 E	12	29	45	5 NM	81	1007.8	16.7	18.3	6	13	29	9	36
SUCCESSFUL VENTURE	LIBERIAN	17	45.0 N	161.8 E	00	35	M 45	1 NM		988.0	5.0	9.0	8	16.5	35	12	24.5
GOLDEN ARROW	JAPANESE	17	40.1 N	159.4 W	06	35	M 42	2 NM	03	1000.0	5.5	6.0	4	8	01	7	11.5
EXPORT CHALLENGER	AMERICAN	17	36.5 N	175.0 E	06	26	47	5 NM	02	995.9	15.0	21.0	8	10	26	10	24.5
GRAND CARRIER	LIBERIAN	17	36.0 N	154.7 E	00	31	M 43	5 NM	03	1018.0	15.0	21.5					
PACIFIC ACE	PANAMANIAN	17	34.8 N	165.6 E	06	29	M 42	5 NM	03	1007.5	16.5	24.0	6	19.5	29	8	50.5
VIOLET	LIBERIAN	18	49.1 N	135.3 W	18	04	M 41	1 NM	53	1017.0	8.0	15.0	10	14.5	08	>13	19.5
HONSHU GLORIA	LIBERIAN	18	37.1 N	178.0 W	00	28	M 43	10 NM	65	1004.5	19.5	19.5	4	19.5	26	10	26
PACMERCHANT	LIBERIAN	18	35.7 N	171.9 E	00	30	M 47	5 NM	02	1010.0	21.0	20.0	5	11.5	30	7	14.5
PRES KENNEDY	AMERICAN	18	54.3 N	176.1 W	00	11	45	5 NM	63	991.9	3.9	4.4	6	14.5	11	12	24.5
PIONEER CRUSADER	AMERICAN	18	13.4 N	142.6 E	12	08	45	1 NM	82	1002.0	28.3	28.4	8	13			
WESTWARD VENTURE	AMERICAN	19	51.9 N	131.9 W	12	04	M 45	10 NM	00	1026.2	3.4	10.0	5	13			
OCEANOGRAPHER	AMERICAN	19	44.2 N	125.3 W	00	20	M 43	200 YD	63	1008.8	10.1	9.8	5	10			
VAN WARRIOR	LIBERIAN	20	40.1 N	177.0 E	00	27	50	10 NM	02	1014.0	7.5	5.0					
SPRUCE	JAPANESE	20	43.6 N	168.0 E	12	16	M 45	1 NM	82	1004.5	9.0	10.0	9	14.5	29	8	14.5
SINCERE 3	LIBERIAN	20	40.8 N	164.9 E	18	19	M 60	2 NM	50	998.7	3.5	6.0					

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		NOV.															
MOBIL MERIDIAN	AMERICAN	20	51.6 N	130.2 W	06	08	M 54	> 25 NM	00	1022.1	6.1	8.8	5	5	03	9	16.5
JUTHLANDIA	LIBERIAN	20	40.8 N	133.4 W	12	35	45	10 NM	97	1019.0	10.0	13.2	10	13	35	10	16.5
PRES KENNEDY	AMERICAN	20	50.1 N	158.2 E	06	12	45	2 NM	51	990.0	1.7	4.4	7	19.5			
PORTLAND	AMERICAN	20	51.0 N	130.5 W	00	02	50	10 NM	02	1023.4	5.6	10.0	6	13	02	7	16.5
SINCERE 3	LIBERIAN	21	4[illegible].5 N	161.2 E	18	25	M 60	1 NM	60	999.0	0.0	4.0			25	10	21
JUTHLANDIA	LIBERIAN	21	41.0 N	135.5 W	00	35	45	10 NM	97	1022.7	14.0	12.8	8	13	35	10	16.5
HONSHU GLORIA	LIBERIAN	21	38.3 N	160.7 E	18	27	M 46	> 25 NM	02	1010.0	16.0	21.0	4	24.5	30	< 6	24.5
VAN WARRIOR	LIBERIAN	21	47.4 N	171.5 E	00	14	55	1 NM	61	991.0	7.5	6.0					
VAN WARRIOR	LIBERIAN	23	43.5 N	159.9 E	06	27	45	2 NM	80	1002.0	8.0	8.0					
PRES EISENHUWER	AMERICAN	23	27.0 N	132.8 E	12	06	41	2 NM	60	1010.8	20.0	25.6	10	11.5	10	12	14.5
MARCONA TRANSPORTER	LIBERIAN	24	28.3 N	137.0 E	00	03	45	5 NM	02	1010.5	20.0	25.5	10	11.5	03	12	13
VAN WARRIOR	LIBERIAN	24	40.9 N	153.5 E	12	32	45	10 NM	03	1014.5	5.5	10.0					
SEATRAIN CONCORD	FRENCH	25	30.6 N	172.1 W	18	23	M 44	2 NM	03	995.0	22.2	20.0	6	19.5			
VAN ENTERPRISE	LIBERIAN	25	50.5 N	167.0 E	18	35	M 45	2 NM	60	987.0	3.5	4.0					
EVER SUMMIT	PANAMANIAN	25	34.6 N	180.0 W	18	29	M 52	2 NM	03	996.9	12.0	19.0			29	>13	29.5
PRESIDENT MADISON	AMERICAN	25	40.4 N	161.5 E	12	32	M 55	10 NM	27	1007.0	5.6	12.8	8	19.5			
ORIENTAL LEADER	LIBERIAN	25	33.2 N	174.3 E	12	33	M 56	5 NM	03	997.6	18.0	19.0					
RUSH	AMERICAN	25	56.6 N	167.3 W	18	05	M 50	2 NM	07	980.6	5.6	6.7	7	13			
GOLDEN GATE BRIDGE	JAPANESE	26	54.0 N	162.0 W	00	21	M 43	5 NM	25	966.0	5.5	6.0	5	10	18	< 6	10
EVER SUMMIT	PANAMANIAN	26	34.1 N	177.7 E	06	29	M 45	2 NM	25	999.0	15.0	18.5			29	7	31
VAN ENTERPRISE	LIBERIAN	26	40.4 N	164.8 E	00	36	M 51	2 NM	60	993.0	4.0	4.0	4	13	36	7	19.5
ASIA MORALITY	LIBERIAN	26	38.2 N	158.7 W	00	16	M 46	2 NM	07	990.0	18.0	17.0	7	18	19	7	16.5
UNIVERSE KURE	LIBERIAN	26	42.5 N	151.2 W	06	16	M 42	5 NM	61	996.2	13.5	13.5	7	11.5			
PRES PIERCE	AMERICAN	26	50.8 N	164.4 E	00	01	45	5 NM	02	997.3	5.0	3.7	5	14.5			
PACSTAR	LIBERIAN	26	39.8 N	171.1 E	00	32	42	2 NM	10	999.2	11.0	16.0	9	10			
PRESIDENT MADISON	AMERICAN	26	41.1 N	176.7 E	23	29	M 50	5 NM	25	984.0	7.2	13.3	10	19.5			
ORIENTAL LEADER	LIBERIAN	26	33.5 N	170.6 E	00	31	M 44	10 NM	02	1005.1	17.5	20.0	6	10	30	6	13
JARVIS	AMERICAN	26	57.6 N	154.7 W	03	06	M 45	5 NM	02	981.9	6.0	7.2	6	6.5			
ARCO ANCHORAGE	AMERICAN	27	54.9 N	140.3 W	18	22	M 45	5 NM	25	994.5	5.5	5.6	5	6.5	22	6	29.5
PRESIDENT MADISON	AMERICAN	27	41.4 N	179.7 E	06	31	M 45	5 NM	01	982.0	8.3	12.8	10	19.5			
PACSTAR	LIBERIAN	27	39.5 N	178.1 E	00	31	41	1 NM	03	999.2	9.0	15.0	9	13			
PRINCE WILLIAM SOUND	AMERICAN	27	57.4 N	141.3 W	18	25	M 50	2 NM	10	979.9	7.2	8.3	5	16.5	25	< 6	24.5
JARVIS	AMERICAN	27	56.6 N	151.9 W	00	11	M 51	5 NM	50	983.4	5.3	7.2	8	13			
GALVESTON	AMERICAN	27	54.3 N	138.5 W	18	24	50	5 NM	03	996.8	8.4	7.8	4	8	24	10	26
PRINCE WILLIAM SOUND	AMERICAN	28	56.7 N	139.8 W	00	28	M 42	2 NM	60	997.6	6.7	7.8	5	19.5	28	< 6	24.5
GALVESTON	AMERICAN	28	54.3 N	139.4 W	00	25	45	5 NM	02	1005.0	9.4	7.8	3	11.5	25	11	29.5
PRES PIERCE	AMERICAN	29	32.9 N	138.3 E	18	28	50	> 25 NM	00	1015.2	14.4	21.1	5	6.5	23	6	10
PUERTO VALLARTA	MEXICAN	29	22.1 N	108.4 W	12	35	M 49	10 NM	02	1025.1	19.0		7	5			
PRES CLEVELAND	AMERICAN	30	40.7 N	173.5 W	12	18	45	1 NM	65	1009.8	13.3	12.8	7	10			
ALEUTIAN DEVELOPER	AMERICAN	30	55.7 N	159.1 W	18	16	45	5 NM	51	1000.5	3.3	5.6	6	8	18	8	18
GEORGE WALTON	AMERICAN	30	48.3 N	131.5 W	06	20	50	2 NM	64	975.5	10.0	13.9			22	6	16.5
MOBIL ARCTIC	AMERICAN	30	50.4 N	134.9 W	00	26	M 42	5 NM	02	1007.8	10.0	8.9	7	11.5	27	10	13
SEALAND TRADE	AMERICAN	30	53.2 N	176.9 W	06	24	50	1 NM	05	997.3	2.0	5.6	5	23	XX	8	24.5
ENVIRONMENTAL BUOYS																	
46004	AMERICAN	1	51.0 N	136.0 W	18	20	M 46			991.3	13.0	11.6	9	19.5			
NORTH PACIFIC OCEAN		DEC.															
PACIFIC VENTURE	PANAMANIAN	1	52.7 N	177.3 W	00	27	M 45	2 NM	02	987.5	4.0	4.5	12	24.5			
PRES JEFFERSON	AMERICAN	2	53.5 N	175.6 E	12	29	45	5 NM	70	997.0	6.0	3.3	3	10	28	10	14.5
PORTLAND	AMERICAN	2	56.6 N	144.3 W	18	21	55	1 NM	28	973.9	5.6	7.2	4	8	21	10	16.5
PACIFIC WING	PANAMANIAN	2	40.0 N	142.6 E	00	20	M 48	5 NM	03	1016.0	13.7	8.0	6	18			
HAKONE MARU	JAPANESE	2	50.9 N	152.9 W	06	21	M 55	1 NM	21	982.5	8.0	9.0					
EXXON NEW ORLEANS	AMERICAN	2	55.3 N	139.8 W	18	22	45	2 NM	16	988.5	11.2	8.9	7	8	21	12	14.5
JUTHLANDIA	LIBERIAN	2	41.2 N	140.1 E	12	27	60	10 NM	00	1013.5	7.0	12.0	8	23	XX	8	26
VANGUARD	LIBERIAN	2	36.7 N	152.0 E	18	18	M 45	5 NM	01	1019.0	18.0	20.0			18	7	11.5
SEA FAN	SINGAPORE	2	39.5 N	145.0 E	05	18	M 51	2 NM	05	1015.0	16.8	5.3	5	29.5			
GLACIER BAY	AMERICAN	3	56.3 N	141.2 W	00	24	24	5 NM	16	983.5	5.8	5.6	6	21	25	12	32.5
HONSHU GLORIA	LIBERIAN	3	44.8 N	177.2 E	18	21	M 61	10 NM	03	1014.0	9.5	10.0					
JUTHLANDIA	LIBERIAN	3	40.7 N	139.1 E	00	27	60	5 NM	02	1024.0	4.0	9.1	10	23			
PRES JEFFERSON	AMERICAN	3	50.4 N	164.7 E	12	23	45	10 NM	02	986.0	3.9	2.8	3	10	23	8	14.5
PORTLAND	AMERICAN	3	57.1 N	145.8 W	00	23	65	1 NM	10	972.9	5.6	7.2	6	13	23	9	23
AMERICA MARU	JAPANESE	3	32.3 N	166.6 W	06	36	M 42	1 NM	62	1013.8	14.5	20.0					
RUSH	AMERICAN	3	55.7 N	178.1 W	00	27	M 42	2 NM	16	995.4	- 0.5	5.0	8	13			
PACIFIC VENTURE	PANAMANIAN	3	50.3 N	166.7 E	00	18	M 45	.5 NM	47	996.0	4.0	4.0	14	24.5	05	>13	24.5
HONSHU GLORIA	LIBERIAN	4	45.2 N	178.9 E	00	21	M 60	5 NM	02	1011.5	10.2	9.0	4	11.5	22	>13	19.5
PRES JEFFERSON	AMERICAN	4	48.4 N	160.4 E	00	32	50	10 NM	02	999.0	3.9	2.8	3	11.5	32	8	14.5
PRES JOHNSON	AMERICAN	4	47.9 N	178.9 W	00	20	50	1 NM	55	1005.0	6.7	5.6	3	6.5	20	< 6	14.5
ORIENTAL SOVERIGN	LIBERIAN	5	44.0 N	153.8 E	06	26	M 55	1 NM	-	989.5	3.0	5.0	5	6.5	16	7	19.5
PRES VAN BUREN	AMERICAN	5	37.0 N	166.0 W	18	30	50	5 NM	02	1006.5	11.1		4	10	30	< 6	16.5
PRES JEFFERSON	AMERICAN	5	44.6 N	153.0 E	06	25	70	5 NM	02	981.7	8.3	3.3	5	14.5	25	9	26
EASTERN PACIFIC	JAPANESE	6	45.3 N	163.1 E	00	27	M 42	5 NM	01	995.5	6.5	6.0	7	13			
GREAT OCEAN	JAPANESE	6	39.8 N	173.2 E	05	31	45	5 NM	02	1004.0	10.0	14.0	10	11.5			
TRANSCOLORADO	AMERICAN	6	33.4 N	120.2 W	06	33	45	10 NM	02	1011.5	11.7	13.4	8	14.5	32	11	19.5
ARCO JUNEAU	AMERICAN	6	50.4 N	145.0 W	18	11	M 45	2 NM	83	1013.8	5.5	3.8	2	8	11	< 6	24.5
ATLANTIC PIONEER	PANAMANIAN	6	50.0 N	176.4 E	06	17	M 45	2 NM	05	994.9	6.0	5.0	3	8	16	7	18
PRESIDENT MADISON	AMERICAN	6	43.3 N	155.1 W	12	15	M 65	5 NM	02	1002.0	12.2	12.2	6	13	15	6	16.5
PRES VAN BUREN	AMERICAN	6	36.7 N	167.7 W	00	33	48	10 NM	18	1015.2	10.6	14.4	5	11.5	33	10	31
PRES JOHNSON	AMERICAN	6	51.7 N	149.4 W	06	12	42	2 NM	02	1020.4	7.8	6.7	5	8	12	6	13
ALEUTIAN DEVELOPER	AMERICAN	8	53.1 N	171.5 W	00	27	M 45	10 NM	02	983.1	1.7	3.3	6	10	27	7	16.5
MAMMOTH FIR	LIBERIAN	9	51.2 N	157.9 W	00	24	M 50	5 NM	02	1002.0	6.0	10.0	9	13			
DEL SOL	AMERICAN	9	25.6 N	113.4 W	12	34	50	10 NM	01	1018.8	11.7	19.4	3	8			
MAMMOTH FIR	LIBERIAN	10	50.6 N	170.5 W	18	26	M 45	5 NM	02	1003.5	4.5	10.0	8	11.5			
ARCO ANCHORAGE	AMERICAN	10	47.6 N	132.5 W	18	26	M 43	5 NM	02	998.1	10.0	8.3	2	5	25	< 6	14.5
ARCO PRUDHOE BAY	AMERICAN	10	50.5 N	131.3 W	18	10	M 54	2 NM	64	999.6	5.5	9.5	7	23			
MONTPELIER VICTORY	AMERICAN	11	13.9 N	95.8 W	18	02	48	10 NM	01	1011.3	26.1	29.4	12	14.5	02	>13	19.5
MOBIL MERIDIAN	AMERICAN	11	53.6 N	134.5 W	00	02	M 45	10 NM	02	1003.1	6.2	8.4	7	13			
MAMMOTH FIR	LIBERIAN	11	50.3 N	171.9 W	00	27	M 50	5 NM	18	1000.0	6.0	10.0	6	23			
GOLDEN DAISY	LIBERIAN	11	29.5 N	161.8 W	18	08	M 45	10 NM	02	1030.5	19.0	20.0					
TRIUMPH	PANAMANIAN	11	49.2 N	135.5 W	00	32	M 44	5 NM	15	1006.0	3.5	11.0	5	18	30	9	19.5
PRESIDENT MADISON	AMERICAN	11	35.0 N	158.7 E	00	21	M 45	10 NM	03	1017.8	20.0	18.9	6	13			
MAMMOTH FIR	LIBERIAN	12	46.5 N	179.2 W	12	25	M 50	5 NM	18	992.7	4.5	10.0	7	24.5			
PRES PIERCE	AMERICAN	12	50.2 N	172.9 W	18	24	45	10 NM	02	986.5	3.6	2.9	4	5	25	8	11.5
MIEI MARU	JAPANESE	13	51.6 N	153.8 W	12	25	M 41	5 NM	02	990.5	5.5	6.0	8	13			
VAN CONQUEROR	LIBERIAN	13	48.3 N	159.2 W	18	26	M 48	2 NM	01	1014.0	5.0	7.0					
ASIA HONESTY	LIBERIAN	13	54.1 N	160.6 W	06	23	M 45	2 NM	27	972.0	6.0	6.0	8	23			
EXXON NEW ORLEANS	AMERICAN	13	53.1 N	135.3 W	18	27	55	5 NM	18	993.6	5.5	10.0	9	24.5			
MAMMOTH FIR	LIBERIAN	13	40.1 N	179.3 E	00	27	M 55	10 NM	18	1005.2	5.5	10.0	7	26			
POLAR ALASKA	LIBERIAN	13	54.6 N	163.1 W	12	24	M 45	5 NM	26	981.0	3.0	5.0	5	13			
RUSH	AMERICAN	13	54.4 N	159.6 W	12	25	M 51	2 NM	60	971.3	6.0	6.8	9	14.5			
PRES PIERCE	AMERICAN	13	51.2 N	166.6 W	06	28	45	5 NM	02	988.8	5.0	4.5	4	8	25	8	19.5
MOBIL MERIDIAN	AMERICAN	14	58.5 N	142.9 W	12	22	M 50	10 NM	02	979.0	4.5	6.0	4	8	22	8	23

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C. Air	Temperature °C. Sea	Sea Waves+ Period sec.	Sea Waves+ Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		DEC.															
GOLDEN EXPLORER	LIBERIAN	14	31.5 N	136.1 W	17	08	M 30	5 NM	60	1026.0	18.5	21.0	8	26	07	10	32.5
OVERSEAS JUNEAU	AMERICAN	14	51.1 N	133.9 W	18	30	50	10 NM	03	1014.5	5.0	7.8	5	23	30	10	23
MAMMOTH FIR	LIBERIAN	14	46.8 N	175.4 E	00	26	M 50	10 NM	18	1014.8	.6.0	9.0	7	23			
OGDEN THAMES	LIBERIAN	14	47.4 N	133.0 W	00	26	M 41	1 NM		1015.0	13.0	12.0					
EXXON PHILADELPHIA	AMERICAN	14	57.9 N	143.2 W	18	27	60	5 NM	02	999.8		7.8			26	9	46
GLACIER BAY	AMERICAN	14	50.7 N	134.7 W	06	26	45	10 NM	25	1005.9	7.2	7.8	6	16.5			
MIEI MARU	JAPANESE	14	52.3 N	156.0 W	00	28	M 42	5 NM	03	1006.0	3.0	5.5	10	16.5	29	12	26
PRINCE WILLIAM SOUND	AMERICAN	14	14.5 N	95.3 W	18	04	M 55	5 NM	05	1012.7	24.4	27.8	6	16.5	04	10	11.5
SEALAND LEADER	AMERICAN	14	46.8 N	176.5 E	00	28	M 45	5 NM	02	1017.9	5.5	5.7	5	13	28	10	19.5
EXXON NEW ORLEANS	AMERICAN	14	54.0 N	138.2 W	18	27	60	5 NM	26	1004.7	2.5	7.7			27	13	24.5
PIONEER CRUSADER	AMERICAN	15	13.9 N	95.8 W	06	02	45	5 NM	03	1013.5	23.3	23.8	4	10	02	6	11.5
OVERSEAS JUNEAU	AMERICAN	15	52.3 N	135.3 W	06	30	44	10 NM	27	1017.0	6.1	8.9	5	14.5	30	8	23
ARCO PRUDHOE BAY	AMERICAN	15	55.3 N	136.0 W	12	19	M 42	5 NM	68	1003.4	2.5	6.7	3	5	27	8	34.5
MOBIL MERIDIAN	AMERICAN	15	57.5 N	140.2 W	00	25	M 70	10 NM	02	995.4	3.4	6.1			25	11	41
PACMERCHANT	LIBERIAN	15	36.6 N	177.4 W	00	03	M 45	5 NM	00	1028.0	12.0	16.0	6	5	03	9	11.5
EXXON NEW ORLEANS	AMERICAN	15	53.9 N	138.4 W	00	28	50	5 NM	02	1011.2	8.0	7.8	XX	24.5			
ARCO ANCHORAGE	AMERICAN	15	58.7 N	145.7 W	00	28	45	5 NM	01	993.6	1.7	3.9	8	11.5	26	12	21
MAMMOTH FIR	LIBERIAN	16	35.9 N	169.0 E	12	18	M 45	5 NM	18	1003.0	18.0	20.0	5	16.5			
PRES MONROE	AMERICAN	16	40.5 N	139.6 W	18	30	45	5 NM	02	1022.7	10.0	12.2	6	10	30	6	19.5
OGDEN THAMES	LIBERIAN	16	44.1 N	145.5 W	18	33	M 50	5 NM	07	1031.5	7.0	12.0					
MOBIL MERIDIAN	AMERICAN	16	53.8 N	134.5 W	00	25	M 45	10 NM	02	1002.5	5.5	7.7			25	10	19.5
SINCLAIR TEXAS	AMERICAN	16	47.7 N	134.3 W	18	35	45	10 NM	50	996.5	6.7	7.2			34	< 6	24.5
ADRIAN MAERSK	DANISH	16	30.8 N	163.6 E	18	34	45	2 NM	02	1007.0	8.0		7	24.5			
PRES MONROE	AMERICAN	17	30.9 N	137.3 W	00	32	41	5 NM	02	1017.9	8.9	12.3	3	8	32	9	19.5
PRES TRUMAN	AMERICAN	17	36.1 N	139.0 W	18	34	48	5 NM	50	1023.4	11.0	17.2	5	19.5	34	>13	26
ARCO ANCHORAGE	AMERICAN	17	48.9 N	133.3 W	00	35	56	10 NM	26	1000.0	5.6	6.7	12	19.5			
BEISHU MARU	JAPANESE	17	51.7 N	161.4 W	00	32	M 40	2 NM	26	1014.0	2.0	10.5	6	13	29	11	36
SINCLAIR TEXAS	AMERICAN	17	47.9 N	134.7 W	00	35	48	10 NM	18	1001.7	6.7	8.3	4	8	34	12	24.5
PACMERCHANT	LIBERIAN	17	39.7 N	170.6 W	00	16	M 55	1 NM		1015.5	15.0	15.0	7	6.5	16	11	13
POLAR ALASKA	LIBERIAN	18	45.5 N	153.7 E	06	25	M 43	10 NM	26	1005.0	0.0	0.0	5	13			
PRES TRUMAN	AMERICAN	18	36.1 N	140.2 W	00	34	48	10 NM	03	1025.2	19.0	16.7	5	19.5	34	>13	26
EXXON NEW ORLEANS	AMERICAN	18	50.8 N	145.5 W	18	10	50	2 NM	05	976.0	1.0	7.8	13	24.5			
ASIA HONESTY	LIBERIAN	18	46.2 N	159.1 E	12	18	M 45	2 NM	10	993.0	1.0	3.0	8	16.5			
ARNOLD MAERSK	DANISH	18	35.3 N	136.8 W	00	33	45	10 NM	25	1016.3	12.5	16.0	5	16.5	30	11	29.5
SINCLAIR TEXAS	AMERICAN	18	49.9 N	137.0 W	00	34	45	10 NM	27	1012.5	5.5	9.5	3	16.5	34	9	26
BEISHU MARU	JAPANESE	19	54.1 N	163.4 W	06	23	M 43	2 NM	02	1010.0	3.5	8.5	5	13			
CHEVRON WASHINGTON	AMERICAN	20	58.3 N	148.1 W	06	28	M 54	5 NM	81	993.5	2.7		2	10	28	6	23
MOBIL MERIDIAN	AMERICAN	20	51.2 N	130.1 W	18	25	45	2 NM	02	1012.5	7.8	8.4	8	10			
HONSHU GLORIA	LIBERIAN	20	38.3 N	144.7 W	06	02	M 41	> 25 NM	03	1021.5	14.8	17.0					
ARCO JUNEAU	AMERICAN	21	53.8 N	139.3 W	18	27	M 50	2 NM	07	993.0	6.0	5.4	8	16.5	27	8	24.5
AMER ALLIANCE	AMERICAN	21	36.9 N	146.3 W	06	02	42	5 NM	01	1017.8	15.0	18.3	6	13	36	10	19.5
MOBIL MERIDIAN	AMERICAN	21	51.9 N	131.4 W	00	27	M 45	10 NM	01	1014.0	6.6	8.6	4	5	28	10	24.5
SANSINENA II	AMERICAN	21	54.7 N	140.8 W	18	27	50	5 NM	18	984.5	3.3	5.6	6	18	27	11	18
GOLDENROD	LIBERIAN	21	54.3 N	161.8 W	06	29	M 47	50 YD	07	1006.0	7.0	5.0	7	16.5			
ARCO SAG RIVER	AMERICAN	22	52.2 N	134.3 W	06	28	M 50	10 NM	02	1000.5	6.8	7.2	3	14.5	28	< 6	18
ARCO JUNEAU	AMERICAN	22	54.2 N	139.9 W	00	29	M 60	2 NM	07	1001.0	6.0	5.3	6	14.5	28	8	23
EXXON SAN FRANCISCO	AMERICAN	22	55.4 N	139.0 W	00	30	45	2 NM	15	993.9	6.3	5.6	6	29.5	28	12	24.5
SANSINENA II	AMERICAN	22	55.0 N	141.4 W	00	31	48	10 NM	02	1000.9	4.4	5.6	2	11.5	31	< 6	23
PRINCE WILLIAM SOUND	AMERICAN	22	50.4 N	132.6 W	00	24	M 50	2 NM	62	1020.0	8.9	10.0	5	11.5	32	6	19.5
MOBIL MERIDIAN	AMERICAN	22	54.3 N	135.3 W	00	26	65	5 NM	02	986.8	5.5	7.8	4	10	27	10	32.5
GOLDENROD	LIBERIAN	22	54.0 N	172.7 W	18	27	M 56	200 YD	07	984.0	5.0	4.0					
PRES JEFFERSON	AMERICAN	22	50.1 N	132.6 W	06	26	45	5 NM	02	1010.8	9.4	6.7	4	11.5	26	8	14.5
SINCLAIR TEXAS	AMERICAN	23	57.2 N	147.6 W	18	27	45	10 NM	02	989.0	4.5	4.5	2	10	27	7	26
GOLDENROD	LIBERIAN	23	53.9 N	173.2 W	00	29	M 42	5 NM	07	995.0	4.6	4.0	12	49	29	>13	57
MOBIL MERIDIAN	AMERICAN	23	58.5 N	143.0 W	12	24	50	10 NM	02	981.4	5.0	7.2	4	8	23	9	16.5
ORIENTAL STATESMAN	LIBERIAN	23	35.9 N	154.9 E	18	14	M 43	1 NM	65	1003.0	14.9	18.5					
PORTLAND	AMERICAN	23	55.4 N	141.1 W	18	26	45	10 NM	02	996.6	4.4	7.2	8	23	26	12	29.5
QUEENS WAY BRIDGE	JAPANESE	24	41.8 N	166.4 W	00	06	M 45	1 NM	63	1001.8	10.0	11.0	7	13			
SINCLAIR TEXAS	AMERICAN	24	56.6 N	145.7 W	00	27	42	10 NM	85	996.3	3.4	3.9	3	10	27	8	26
WASHINGTON RAINBOW	JAPANESE	24	32.7 N	155.1 E	12	24	M 50	1 NM		1007.0	18.0	20.0	5	6.5	25	8	6.5
HONSHU GLORIA	LIBERIAN	24	37.0 N	170.6 W	06	24	M 50	10 NM	03	1012.0	13.0	16.5	4	26	29	< 6	29.5
PRES TRUMAN	AMERICAN	24	34.8 N	157.1 E	18	27	50	5 NM	03	1003.6	16.0	19.4	6	16.5	27	>13	29.5
PORTLAND	AMERICAN	24	55.8 N	142.1 W	00	27	45	10 NM	18	1000.0	3.9	7.8	8	19.5	27	9	26
MEDITERRANEAN CARRIER	BRITISH	24	34.1 N	159.5 E	18	25	42	10 NM	02	1004.5	19.5		3	16.5	23	9	23
AMER LANCER	AMERICAN	24	43.7 N	163.6 E	18	09	55	1 NM	65	980.0	7.8	5.6					
GOLDENROD	LIBERIAN	25	51.3 N	167.0 E	18	04	M 61	200 YD	71	993.0	0.0	3.0	6	10	04	>13	50.5
ASIAN TRANSPORTER	LIBERIAN	25	47.7 N	158.2 E	00	34	M 45	50 YD	45	985.0	4.0	7.0			34	>13	32.5
PRES TRUMAN	AMERICAN	25	34.6 N	156.8 E	00	27	55	5 NM	03	1008.1	17.2	19.0	6	26	27	>13	36
MEDITERRANEAN CARRIER	BRITISH	25	34.4 N	160.6 E	00	27	45	10 NM	03	1007.5	18.0		3	16.5	26	12	23
GOLDENROD	LIBERIAN	26	50.7 N	164.9 E	00	02	M 51	1 NM	07	999.0	0.0	2.0	7	19.5	02	>13	52.5
HONSHU GLORIA	LIBERIAN	26	36.0 N	175.2 E	18	30	M 52	> 25 NM	01	1006.0	13.0	18.0	5	26	30	8	29.5
JOHN TYLER	AMERICAN	26	32.8 N	177.4 W	18	22	45	5 NM	03	1008.8	17.3	15.6	5	8			
POLAR ALASKA	LIBERIAN	27	52.6 N	169.8 E	12	36	M 45	5 NM	85	991.0	- 1.0	2.0	7	13			
QUINTINA	LIBERIAN	27	35.7 N	179.5 E	00	24	45	10 NM	80	1005.0	17.0	16.0	5	16.5			
SEALAND MC LEAN	AMERICAN	27	37.1 N	179.7 E	00	29	50	2 NM	25	1003.4	10.0	12.8	2	6.5	29	7	32.5
ARCO FAIRBANKS	AMERICAN	27	48.6 N	126.9 W	12	32	M 45	10 NM	00	1014.2	6.0	8.9	5	8	30	8	13
HONSHU GLORIA	LIBERIAN	27	35.9 N	172.0 E	18	32	M 54	1 NM	27	1012.0	12.0	18.0					
LING YUNG	CHINESE	27	33.0 N	179.5 W	18	27	45	10 NM	13	1013.5	16.0	13.5	9	32.5			
JOHN TYLER	AMERICAN	27	33.5 N	179.2 W	00	27	45	10 NM	02	1013.0	13.3	19.5	6	14.5			
ORIENTAL EDUCATOR	BRITISH	28	34.5 N	145.5 E	15	08	45	.5 NM	65	998.0	15.0	20.0		8	08	X	16.5
QUINTINA	LIBERIAN	28	35.5 N	176.6 E	00	24	55	10 NM	80	1014.5	16.0	16.0	5	16.5			
HONSHU GLORIA	LIBERIAN	28	35.7 N	171.8 E	00	32	M 42	> 25 NM	03	1019.6	12.7	17.5	4	10.5	30	8	26
JOHN TYLER	AMERICAN	28	33.2 N	175.2 E	06	29	45	5 NM	03	1023.0	13.4	18.4	4	8	29	< 6	14.5
OGDEN THAMES	LIBERIAN	29	35.2 N	141.5 E	12	23	M 48	5 NM	16	1006.7	17.2	21.0					
PACBARON	LIBERIAN	29	32.8 N	164.4 E	00	18	M 45	2 NM	02	1015.0	19.0	19.0	7	10	18	10	13
PACIFIC WING	PANAMANIAN	29	36.3 N	151.6 E	18	27	M 54	.25 NM	65	1000.0	10.0	11.0					
HONSHU GLORIA	LIBERIAN	29	35.8 N	165.3 E	06	18	M 50	10 NM	03	1004.0	17.0	20.0	5	24.5	18	8	29.5
PRES JEFFERSON	AMERICAN	30	53.5 N	173.5 E	12	24	50	10 NM	20	966.5	2.8	2.2	8	10	24	8	19.5
AMER LANCER	AMERICAN	30	38.8 N	124.6 W	18	34	45	10 NM	01	1021.0	7.2	10.6	7	18			
SEALAND MC LEAN	AMERICAN	30	35.6 N	153.2 E	00	25	50	2 NM	82	997.8	13.3	12.2	5	5	25	7	24.5
HONSHU GLORIA	LIBERIAN	30	36.0 N	161.6 E	06	20	M 48	10 NM	03	1000.0	17.0	17.0	4	16.5	23	6	19.5
PRES JEFFERSON	AMERICAN	31	51.7 N	165.3 E	18	25	50	5 NM	70	968.2	- 1.7	1.7	5	11.5	25	8	19.5
AMERICA MARU	JAPANESE	31	35.2 N	143.1 W	18	13	M 41	1 NM	82	993.0	17.0	19.0	5	10	18	8	8
VAN ENTERPRISE	LIBERIAN	31	47.4 N	179.7 E	00	15	M 52	2 NM	51	980.0	6.0	3.5	3	19.5	20	< 6	29.5
HONSHU GLORIA	LIBERIAN	31	37.3 N	157.7 E	06	32	M 41	> 25 NM	02	1015.0	9.0	15.0	3	6.5	28	< 6	13
ENVIRONMENTAL BUOYS																	
46004	AMERICAN	13	51.0 N	136.0 W	06	19	M 43			1007.9	7.7	9.1	8	16.5			
46004	AMERICAN	14	51.0 N	136.0 W	15	28	M 44			1014.3	3.6	8.9	10	26			
46005	AMERICAN	16	46.0 N	131.0 W	23	32	M 45			992.7	5.0	10.7					
46005	AMERICAN	17	46.0 N	131.0 W	00	34	M 47			993.0	4.8	10.8	8	19.5			

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 35 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest windspeed was selected.

Table 9
U.S. Cooperative Ship Weather Reports

November and December 1978

SHIP NAME	VIA RADIO	VIA MAIL
ACONCAGUA	11	
ADRIAN MAERSK	66	149
AFRICAN METEOR	8	54
AIMEE LYKES	16	67
ALBATROSS IV	42	
ALEX STEPHENS	18	47
ALVINA	10	22
AMERICAN ACE	45	114
AMERICAN ARCHER	74	116
AMERICAN CHALLENGER	35	114
AMERICAN CORSAIR	5	69
AMERICAN LARK	8	133
AMERICAN LEGION	21	115
AMERICAN RANGER	22	73
AMOCO MILFORD HAVEN	59	48
ANCO STANE	62	
ANNIE JOHNSON	27	37
ARCO ANCHORAGE	70	111
ARCO JUNEAU	112	64
ARCTIC TOKYO		39
ARNOLD MAERSK	36	86
ASHLEY LYKES	5	29
ASIA HONESTY	20	149
ASIAN ASSURANCE	15	
ATLANTIS II	1	16
AUSTRAL ENVOY	32	51
AUSTRAL PILGRIM	5	35
AXEL MAERSK	15	40
BALTIMORE TRADER	28	96
BAYANO	28	53
BERNES	40	
BOGASARI SATU		18
BOUTWELL WHEC 719	49	52
BRINTON LYKES	2	16
C V LIGHTNING	18	84
CAMPBELL WHEC 32	3	87
CARIBIA	19	
CHALLENGER		83
CHARLESTON	15	37
CHAVEZ	77	154
CHESNUT HILL	23	
CHEVRON BURNABY	3	147
CHEVRON EDINBURGH	19	194
CHEVRON KENTUCKY	66	
CHEVRON NAGASAKI	81	
CHEVRON PERTH	12	166
CHOAPA	10	17
COLUMBUS AMERICA	16	60
COLUMBUS WELLINGTON	49	112
CORAL ACE	19	
COSMOS GIENAH	44	96
CRESSIDA	21	56
DALLAS WHEC 716	17	16
DAVID D. IRWIN	22	37
DEEPSEA MINER II	31	153
DEL SOL	8	47
DELTA ARGENTINA	15	52
DELTA MAR	1	10
DELTA VENEZUELA	4	
DITTE SKOU	35	
DRAGAMINAS	1	
EASTERN BRIDE	16	
EASTERN PACIFIC	22	12
EASTERN WISEMAN	16	
EIDANGER		10
ELIZABETH LYKES	15	45
EUROPRINCESS	2	
EVER SUMMIT	20	112
EXPORT AIDE	3	
EXPORT BUYER	22	9
EXPORT FREEDOM	22	84
EXXON BANGOR	16	37
EXXON GETTYSBURG	8	15
EXXON LEXINGTON	14	16
EXXON SEATTLE	21	51
FALSTRIA	46	93
FREDERICK LYKES	19	
GALLEON CORAL	12	
GENE TREFETHEN	81	
GEORGE M KELLER	1	107
GLACIER WAGB 4	106	
GLOMAR CHALLENGER	111	195
GOLDEN DAISY	39	98
GOLDEN GATE BRIDGE	102	87
GOLDEN ROD	10	68
GREAT LAND	56	54
GREEN HARBOUR	5	83
GREEN WAVE	7	29
GULF SHIPPER	2	9
HADJI AGUS SALIM	1	
HAWAIIAN	2	
HERON	77	66
HOEGH ELAN	13	
HOEGH MERCHANT	13	
HOLYLIGHT		46
HOUSTON	14	
HUMACAO		43
INGER	3	157
IRONWOOD WLB 297	5	
J R GREY		164
IRONWOOD WLB 297	5	
JAMES E O'BRIEN	12	
JAPAN AMBROSE	43	30
JAVARA		16
JOHN B WATERMAN	22	70
JOSEPH LYKES	11	33
KATHY	2	
KINGDOM VENTURE	13	
KOPAA	54	92
KOREAN COMMANDER	4	
L.W. FUNKHOUSER	14	185
LASH ATLANTICO	21	45
LEO	19	
LIMARI	5	16
LORD NIAGARA	1	
LURLINE	107	155
MALLORY LYKES	14	48
MAMMOTH PINE	27	49
MANUKAI	79	115
MARCONA CONVEYOR	40	82
MARDI GRAS	31	41
MARITIME ACE	18	41
MARITIME HARMONY	1	
MARITIME RELIANCE	35	78

	VIA RADIO	VIA MAIL
ACUSHNET WAGO 167		143
AFRICAN COMET	5	
AFRICAN NEPTUNE	16	39
ALASKA	11	
ALBERT MAERSK	10	39
ALLISON LYKES	4	29
AMELIA TOPIC		44
AMERICAN ALLIANCE	43	146
AMERICAN ARGOSY	19	97
AMERICAN CHAMPION	33	133
AMERICAN COURIER	34	60
AMERICAN LEADER	28	83
AMERICAN LIBERTY	50	160
AMERICAN RELIANCE	31	73
AMOCO TRINIDAD	42	66
ANDALUSIA	5	
ANTE TOPIC	22	38
ARCO ENTERPRISE	16	61
ARCO PRESTIGE	9	58
ARECIBO	58	69
ARTHUR MAERSK	20	40
ASIA BEAUTY	33	13
ASIA HUNTER	10	
ATHEL LAADKI	2	
AUSTRAL ENDURANCE	21	66
AUSTRAL LIGHTNING	54	102
AUSTRAL PILOT	4	35
B T SAN DIEGO	19	110
BARRANCA	50	122
BEISHU MARU	69	51
BLUE OCEAN	23	132
BOHEME	25	62
BRAZOS	63	152
BUNGA SRIPAGI	16	
C V STAGHOUND	18	58
CAPE FREELS	29	64
CARMEN A	1	
CHALMETTE	17	26
CHARLOTTE LYKES	8	72
CHENNAI SADHANAI	25	154
CHEVRON ANTWERP	3	159
CHEVRON CALIFORNIA	79	121
CHEVRON FELUY	9	
CHEVRON LONDON		196
CHEVRON NORTH AMERICA	14	208
CHEVRON SOUTH AMERICA	5	114
CITRUS WLB300	5	
COLUMBUS AUSTRALIA	7	85
COMET	22	81
CORANTIJN	33	88
COUNCIL GROVE	6	
CRISTOBAL	19	73
DANWOOD ICE	31	42
DAVID P REYNOLDS	97	126
DEFIANCE	7	43
DELAWARE GETTY	5	14
DELTA BRASIL	6	
DELTA MEXICO	17	27
DEPENDABLE WMEC 626	14	
DJATISARI	3	
DRUCILLA U	24	53
EASTERN FORTUNE	3	
EASTERN SUN	1	
EASTERN WORLD	25	
EL PAMPERO	1	
ENNA G	43	145
EVANO	3	88
EVER VICTORY	3	6
EXPORT AMBASSADOR	11	28
EXPORT CHALLENGER	28	75
EXPORT LEADER	30	114
EXXON BATON ROUGE	1	
EXXON HOUSTON	19	79
EXXON NEW ORLEANS	40	74
EXXON WASHINGTON	2	29
FESTIVALE	28	53
FRIENDSHIP	46	168
GALLEON JADE	7	30
GENEVIEVE LYKES	5	57
GEORGE WALTON	13	43
GLACIER BAY	48	134
GLOMAR PACIFIC		201
GOLDEN DOLPHIN		5
GOLDEN LOTUS	31	7
GOWANBANK	7	
GREAT OCEAN	14	54
GREEN ISLAND	3	17
GUAYAMA	70	113
GULF TRADER	16	49
HAKONE MARU	91	41
HAWAIIAN CITIZEN	78	136
HESS VOYAGER	78	140
HOEGH ELITE	8	
HOEGH MERIT	29	64
HONGKONG PHOENIX	17	28
HOWARD W BELL		48
IDAHO	12	35
INGHAM WHEC 35	24	33
ITALY MARU	36	41
J T HIGGINS		47
ITALY MARU	36	41
JAMES LYKES	23	41
JAPAN CAUBO	12	91
JEAN LYKES	8	34
JOHN LYKES	29	41
JUPITER	27	
KEIYO	30	102
KINYO MARU	61	67
KOREA PHOENIX	7	
KOREAN FIR	10	7
LAKE BERRYESSA	41	
LASH ITALIA	15	54
LESLIE LYKES	26	
LING YUNG	59	83
LOUISE	34	68
MADONNA	11	
MALLOW WLB 396	9	10
MANHATTAN	53	142
MANULANI	79	131
MARCONA EXPORTER	59	145
MARGARET JOHNSON	28	19
MARITIME BRILLIANCE	21	30
MARITIME INVESTOR	18	
MARJORIE LYKES	12	34

	VIA RADIO	VIA MAIL
ADABELLE LYKES	6	
AFRICAN DAWN		80
AFRICAN SUN	7	22
ALASKA STANDARD	31	27
ALERT	4	
ALMERIA LYKES	39	76
AMERICA MARU	112	44
AMERICAN APOLLO	16	106
AMERICAN ARROW	56	88
AMERICAN CHARGER	2	100
AMERICAN INDEPENDENCE	16	126
AMERICAN LEGACY	49	110
AMERICAN LYNX	26	132
AMERICAN TRADER	4	25
ANCHORAGE	10	18
ANDERS MAERSK	31	67
ANTONIA JOHNSON	27	109
ARCO FAIRBANKS	128	151
ARCO PRUDHOE BAY	106	111
ARILD MAERSK	19	57
ARTHUR MIDDLETON		31
ASIA BRAVERY	22	100
ASIA MORALITY	25	47
ATLANTIC HIGHWAY	25	34
AUSTRAL ENSIGN	58	79
AUSTRAL MOON	67	137
AUSTRAL RAINBOW	60	122
BAKNES	29	
BARTLETT AGOR 13	17	
BEL HUDSON	1	
BLUEBIRD	87	63
BORINQUEN	69	145
BREWSTER	18	40
BURMAH ONYX	1	
CALIFORNIA RAINBOW	29	62
CARBIDE SEADRIFT	21	136
CARNIVALE	46	59
CHANCELLORSVILLE	6	
CHASE WHEC 718	48	
CHEROKEE WMEC 165	62	21
CHEVRON ARIZONA	108	150
CHEVRON COLORADO	35	28
CHEVRON FRANKFURT		84
CHEVRON LOUISIANA	20	13
CHEVRON OREGON	15	26
CHEVRON WASHINGTON	60	115
COLORADO	88	151
COLUMBUS NEW ZEALAND	31	78
CONALCO	1	
CORNUCOPIA	30	42
COURAGEOUS WMEC 622		50
CRYSTAL REED	15	
DARIEN	1	
DAVID PACKARD		51
DEL ORO	3	73
DELAWARE II	67	34
DELTA CARIBE	40	115
DELTA PARAGUAY	2	30
DIANA PROSPERITY	25	92
DOCTOR LYKES	32	120
DURABLE	104	
EASTERN JADE	29	
EASTERN TREASURE	3	22
EDELWEISS	14	24
EL PASO SONATRACH	6	27
ESSO KOBE	3	35
EVELYN MAERSK	1	
EXPORT ADVENTURER	5	26
EXPORT BANNER	17	99
EXPORT CHAMPION	12	26
EXPORT PATRIOT	33	124
EXXON BOSTON	8	10
EXXON HUNTINGTON	7	4
EXXON PHILADELPHIA	22	29
FAIRLOAD	1	
FIGARO	1	
FRONTIER	3	
GALVESTON	38	48
GENISTA	17	
GEORGIANA	12	
GLADIOLUS	34	57
GLORIOUS SHINKO	6	
GOLDEN EXPLORER	19	16
GOLDEN ORCHID	5	
GRACE	19	
GREAT REPUBLIC	25	41
GREEN PORT		35
GULF BANKER	13	58
GUNDA BROVIG	7	
HAMILTON WHEC 715	23	29
HAWAIIAN QUEEN	73	107
HIEI MARU	106	76
HOEGH MALLARD	19	78
HOEGH OPAL	11	
HONSHU GLORIA	55	179
HOWELL LYKES	13	39
ILLINOIS	51	113
IRIS ISLAND	46	136
ITAPUCA	3	
JACKSONVILLE	6	97
ITAPUCA	3	
JAPAN ACE	108	38
JAPAN RAINBOW	19	39
JEFF DAVIS	8	32
JOHN TYLER	17	57
JUTHLANDIA	18	104
KENTUCKY HOME	1	
KOFUKU MARU		65
KOREA RAINBOW	3	
KOREAN LEADER	13	13
LAKE PALOURDE	22	8
LASH PACIFICO	13	48
LETITIA LYKES	13	93
LLOYD CUIABA	1	
LOUISE LYKES	21	73
MAGDALENA	62	
MALMROS MONSOON	6	15
MANISTEE	30	
MANZANARES	36	70
MARCONA TRADER	1	
MARIA U	2	14
MARITIME DOMINION	26	
MARITIME PIONEER	2	
MARSHFIELD		84

	VIA RADIO	VIA MAIL
ADM WM M CALLAGHAN	40	84
AFRICAN MERCURY	11	31
AGUADILLA	101	103
ALASKAN	64	112
ALEUTIAN DEVELOPER	19	24
ALVA MAERSK	33	140
AMERICAN ACCORD	40	116
AMERICAN AQUARIUS	19	78
AMERICAN ASTRONAUT	26	130
AMERICAN CHIEFTAIN	14	68
AMERICAN LANCER	32	104
AMERICAN LEGEND	22	78
AMERICAN RACER	18	99
AMOCO CONNECTICUT	1	
ANCO DUKE	69	40
ANNA MAERSK	14	54
AQUILA	22	16
ARCO HERITAGE	94	131
ARCO SAG RIVER	87	151
ARIZONA	28	68
ARTLENBURG	26	79
ASIA HERON	25	33
ASIA ZEBRA	21	20
ATLANTIC PIONEER	12	93
AUSTRAL ENTENTE	29	94
AUSTRAL PATRIOT	12	57
AVILA	14	31
BALD BUTTE	6	88
BARNA	13	30
BERGLJOT	16	22
BOGASARI DUA	3	23
BOSTON	38	80
BRIGHT HOPE	17	
BUTTONWOOD WLB 306	64	
CALIFORNIAN	50	74
CARIBBEAN CARRIER	1	
CAROLINA	29	60
CHARLES PIGOTT	17	178
CHASTINE MAERSK	16	27
CHERRY VALLEY	27	80
CHEVRON BRUSSELS		180
CHEVRON COPENHAGEN		134
CHEVRON HAWAII	61	95
CHEVRON MISSISSIPPI	55	69
CHEVRON PERNIS	55	151
CHI CHING	11	
COLUMBIA RIVER L/V	457	
COLUMBUS VICTORIA	34	45
CONDATA	6	6
CORONADO	1	
COVADONGA	5	25
CUNARD AMBASSADOR	1	
DAUNTLESS CG	56	
DECISIVE WMEC-629	24	29
DEL RIO	12	89
DELTA AMERICA	5	10
DELTA ECUADOR	3	8
DELTA URUGUAY	11	42
DILIGENCE WMEC 616	30	
DORIC	15	22
EAGLE CHARGER	21	5
EASTERN MUSE	1	
EASTERN VENTURE		82
EDGAR M QUEENY	45	59
EL PASO SOUTHERN	38	116
EUROFREIGHTER	37	
EVER SPRING	26	76
EXPORT AGENT	8	18
EXPORT BUILDER	13	19
EXPORT COURIER	4	36
EXXON BALTIMORE	30	36
EXXON FLORENCE	22	76
EXXON JAMESTOWN	55	87
EXXON SAN FRANCISCO	51	79
FAIRWIND	6	
FRANCIS SINCERE NO 6	32	
GAGE LUND	45	
GEMINI	3	87
GEORGE B KELEZ	15	
GIBRALTAR PANSY	18	
GLOBAL MARITIME	22	33
GOLDEN ARROW	109	92
GOLDEN GATE	12	64
GOLDEN RAY	6	
GRAND CARRIER	23	50
GREEN AUKLET	30	
GREEN VALLEY	1	30
GULF FARMER	15	61
GUTENFELS	5	
HARDANGER	10	10
HERMINA	60	
HILLYER BROWN	14	31
HOEGH MASCOT	2	17
HOHSING ARROW	5	27
HOTAKA MARU	107	70
HUDSON T-AO 184	32	54
INACHUS STAR	22	57
IRIS QUEEN	64	
J LOUIS	78	127
JALAYAMINI	53	
J LOUIS	78	127
JAPAN AMBASSADOR	25	19
JARVIS WHEC 725	15	177
JELA TOPIC	8	
JOSEPH HEWES	26	107
KASHU MARU	119	57
KEYSTONER	62	147
KONSUL RETZLAFF	26	
KOREAN CHALLENGER	1	
KOREAN PRIDE	18	
LAKE SHASTA	6	
LAUREL	39	17
LIECHTENSTEIN	25	
LONG BEACH	14	82
LUIGI GRIMALDI	77	
MAINE	24	71
MAMMOTH FIR	35	66
MANUAWILI	69	96
MAR DE CORTEZ	39	149
MARCONA TRANSPORTER	17	93
MARIAS TAO-57		29
MARITIME FORTUNE	26	
MARITIME QUEEN		21
MASON LYKES	27	73

TOTAL WEATHER REPORTS RECEIVED FROM US COOPERATIVE OBSERVING SHIPS NOVEMBER AND DECEMBER 1978

SHIP NAME	VIA RADIO	VIA MAIL
MATHIESON	3	
MAYAGUEZ	20	124
MERCY	23	
MILENA	1	
MOBIL AERO	5	83
MOBIL VENTURE	1	
MOBILOIL	8	16
MONTANA	31	74
MORMACDRACO	11	36
MORMACSEA	8	77
MORMACVEGA	28	56
MOUNT VERNON VICTORY	2	40
NECHES	3	7
NEW JERSEY SUN		56
NOPAL LANE	9	11
NORDHVAL	43	
NORTH STAR III	15	23
OCEAN HAPPINESS	1	
OCTA	16	21
OGDEN MISSOURI	1	
OGDEN WILLAMETTE	33	69
OPHELIA	1	
ORE JUPITER	29	11
ORIENTAL EDUCATOR	67	152
ORIENTAL SOVEREIGN	47	75
OVERSEAS ARCTIC	12	61
OVERSEAS NATALIE	10	59
OVERSEAS VIVIAN	2	15
PACDUCHESS	17	18
PACIFIC ARROW	120	86
PACIFIC WING	54	186
PACMONARCH	1	
PALLAS	17	
PASSUMPSIC AO-107		125
PEARL VENTURE	1	
PERSIAN REEFER	67	132
PINK SKY	12	
PIONEER CRUSADER	48	102
PONCE	5	29
PRESIDENT CLEVELAND	35	48
PRESIDENT JACKSON	17	52
PRESIDENT MADISON	79	154
PRESIDENT POLK	51	113
PRESIDENT TRUMAN	46	104
PROSPERITY QUEEN	48	74
PVT LEONARD C BROSTROM	23	7
RACHEL	1	
REGINA CELI	6	
REVERE	54	126
ROBERT E LEE	7	29
ROSE		96
ROYAL VIKING STAR	11	6
SALVADUR	10	18
SAMOAN REEFER	3	
SAN JUAN	101	155
SANKOSTAR	14	
SANTA ELISABETTA		4
SANTA MARIANA	29	78
SEA SOUNDER	11	41
SEALAND EXCHANGE	49	118
SEALAND MCLEAN	40	115
SEALAND VENTURE	24	117
SEATRAIN CONCORD	83	150
SEAWAY	7	72
SERAFIN TOPIC	4	46
SHIRLEY LYKES	11	
SINCLAIR TEXAS	42	125
SOCONY VACUUM		74
SOUTHWARD	51	52
STARWARD	13	3
STOLT NORNESS	1	
STREAM RUDDER	25	
SUNNY OCEAN	16	
SVENDBORG MAERSK	20	65
TAEHO	1	
TALUGA T-AO-62		21
TANEY WHEC 37	37	
TALUGA T-AO-62		21
TEXACO FLORIDA	64	117
TEXACO RHODE ISLAND	13	7
THOMAS JEFFERSON	9	
THOMAS WASHINGTON	22	128
TOHBEI MARU	46	26
TORM THYRA	1	
TOYOTA MARU 14	45	50
TRANSCOLUMBIA	16	36
TRIUMPH	22	44
TUCURINCA	1	
UNION PROGRESS		51
UNIVERSE	27	35
VALOR	8	21
VAN WARRIOR	39	132
VICTORIA U	24	
VIRGINIA STAR	6	
WASHINGTON TRADER	42	63
WESTERN SUN	1	57
WORLD CHAMPION	2	
YAMASHIN MARU	99	84
ZENLIN GLORY	3	
ZIM TOKYO	54	48
ABYT	18	16
D5CX	27	91
D7SD	13	39
ELFY		100
ELPJ	23	34
H3SY		47
JLJL	119	31
KHKB	4	37
KPED		7
KVYN		69
LEVH	23	69
NHNF		23
NZIX		49
SJOA	2	52
WCHG	41	32
WFQE	19	172
WPGH		57
WYX4537		93
YTCD	15	28
3EBR	11	26
5MME	5	68
6ZBT		77
6ZXD	25	50
9VUL	32	33
MATSONIA	82	139
MEADOWBROOK	31	105
METEOR T-AKR 9	41	107
MILLER FREEMAN	2	
MOBIL ARCTIC	48	117
MOBILE MERIDIAN	31	107
MODOC WMEC-194	10	
MONTPELIER VICTORY	14	129
MORMACLYNX	13	23
MORMACSKY	12	49
MORMACWAVE	22	33
MT MITCHELL	19	19
NEVADA	32	70
NEWARK	34	41
NOPAL SEL	25	
NORDIC LOUISIANA	37	
NORTHWIND WAGB 282	112	220
OCEAN HARMONIA	13	
OGDEN CONGO	19	
OGDEN SENEGAL	25	114
OJI GLORIA	65	
ORANGE	82	
ORE MERIDIAN	52	77
ORIENTAL EXECUTIVE	21	82
ORIENTAL STATESMAN	18	55
OVERSEAS EVELYN	1	
OVERSEAS NEW YORK	12	116
OVERSEAS WASHINGTON	24	44
PACEMPEROR	9	5
PACIFIC ERA	36	80
PACLADY	18	29
PACPRINCE	18	
PAN ASIA	2	20
PATUCA	1	
PEIRCE	16	
PHILADELPHIA	54	96
PIONEER COMMANDER	10	31
PIONEER MOON		61
PORTLAND	50	107
PRESIDENT EISENHOWER	54	123
PRESIDENT JEFFERSON	58	163
PRESIDENT MC KINLEY	54	130
PRESIDENT ROOSEVELT	63	136
PRESIDENT VAN BUREN	26	81
PUEBLA	5	
QUEENS WAY BRIDGE	108	41
RAINIER	8	8
RELIANCE WMEC 615	47	
RICHARD	47	70
ROBERT TOOMBS	7	
ROSE CITY	28	104
RUSH WHEC 723	24	147
SAM HOUSTON	13	109
SAMUEL CHASE	6	62
SAN MARCOS	59	97
SANKOSUN	7	14
SANTA FE	19	101
SANTA MERCEDES	39	70
SEALAND COMMERCE	60	136
SEALAND FINANCE	40	103
SEALAND PRODUCER	16	108
SEALIFT PACIFIC	20	24
SEATRAIN LEXINGTON	60	143
SEBASTIAN LERDO DE TEJ	1	9
SEVEN OCEAN	38	111
SHUNWIND	39	23
SKYWARD	30	42
SOHIO INTREPID	2	
SPIRIT OF LIBERTY	1	
STATUE OF LIBERTY	1	
STONEWALL JACKSON	10	
SUCCESSFUL VENTURE	22	34
SUNNY STATE	20	
SWEETBRIER WLB 405	1	
TAI TUNG	28	
TAMAKA	17	
TARA	1	
TAMARA	17	
TEXACO MARYLAND	7	64
TEXAS SUN		73
THOMAS LYNCH	3	
THOMPSON LYKES	11	25
TOKYU RAINBOW	29	22
TOWNSEND CROMWELL	8	19
TOYOTA NO 24	29	42
TRANSONEIDA	82	161
TROLL LAKE	87	
TYSLA	2	
UNIQUE FORTUNE	10	83
UNIVERSE KURE	25	155
VAN CONQUEROR	33	129
VANGUARD	11	74
VIGOROUS WMEC-627	5	4
VOLNAY	38	
WAYFARER	17	
WESTWARD VENTURE	57	84
WORLD MEDAL	4	
YEH YUNG	41	41
ZIM HONGKONG	17	13
ZOELLA LYKES	9	27
DABR		54
D5DH	7	29
D7XR		10
ELJN	15	24
GODZ	1	50
JDWV	59	18
KAFH		13
KHLN		97
KRLD	3	6
KYSG	31	48
LEVX		35
NHOS		39
OUIU	31	61
S6CC	14	49
WCSG		58
WHTB		8
WPIP		1
WZY9373		56
ZCKV	80	147
3FCW	8	6
5MOJ	40	57
6ZMT	8	5
9VAJ	9	32
9VUP	8	11
MAUI	68	97
MEDITERRANEAN CARRIER	44	114
MICHIGAN	15	60
MING CHALLENGER	30	38
MOBIL LUBE	48	107
MOBILFUEL	30	99
MOHAWK	15	51
MORMACALTAIR	14	
MORMACRIGEL	18	20
MORMACSUN	36	45
MORNING GLORY	40	
NANCY LYKES	24	
NEW ENGLAND HUNTER		69
NEWCASTLE CLIPPER	33	
NORBU	11	
NORDIC PRINCE	13	17
OAKLAND	1	
OCEANIC	120	169
OGDEN FRASER	20	
OGDEN THAMES	75	126
OLEANDER	46	56
ORCO MINER		46
ORE VENUS		7
ORIENTAL FINANCIER	5	14
OTTO N. MILLER	12	114
OVERSEAS JOYCE	22	85
OVERSEAS OHIO	3	
PACBARON	6	25
PACGLORY	23	
PACIFIC SAGA	48	8
PACMAJESTY	5	
PACPRINCESS	21	
PANCARIBE	1	
PAUL L FAHRNEY		32
PENNMAR	2	16
PHILIPPINE RIZAL	7	16
PIONEER CONTENDER	27	114
POLAR ALASKA		94
PORTUGAL MARU	21	17
PRESIDENT FILLMORE	32	71
PRESIDENT JOHNSON	64	106
PRESIDENT MONROE	15	83
PRESIDENT TAFT	50	102
PRESIDENT WILSON	18	
PURE OIL	55	124
QUINTINA	14	31
RED ARROW	49	74
RENATE JACOB	3	
RIGOLETTO	6	16
ROBERTSBANK	52	107
ROYAL VIKING SEA	32	27
RUTH LYKES	8	28
SAM RATULANGIE	2	
SAMUEL S	15	9
SAND SHORE	34	68
SANSINENA II	41	119
SANTA MAGDALENA	17	36
SANTA PAULA	1	
SEALAND CONSUMER	33	95
SEALAND GALLOWAY	9	70
SEALAND RESOURCE	28	77
SEATIGER	41	93
SEATRAIN PRINCETON	27	129
SENTINEL	64	114
SHELDON LYKES	1	77
SINCERE NO 3	4	97
SNOW STORM	7	
SOLON TURMAN	8	44
SPRUCE	15	45
STELLA LYKES	42	71
STORIS WAGB 38	10	
SUECIA	12	8
SUNWARD	1	
T F L INDEPENDENCE	28	35
TAIKO VENTURE	31	
TAMAROA WMEC-166	18	24
TARPON		31
TAMAROA WMEC-166	18	24
TEXACO MISSISSIPPI		15
TEXAS TRADER	4	
THOMAS MAERSK	9	30
THOMPSON PASS	21	69
TOLUCA	7	
TOYOTA MARU 10	129	68
TRANSCHAMPLAIN	79	161
TREIN MAERSK	3	30
TROLL RIVER	1	
UNIMAK WTR-379	58	57
UNITED SEA ANGEL	9	
UTE ATF 76		40
VAN ENTERPRISE	28	83
VELMA LYKES	23	107
VILLANGER	4	
WALTER RICE	54	144
WECOMA	74	95
WHITING	11	
WORLD RUBY	28	
YOUNG AMERICA	10	56
ZIM MONTREAL		27
ABEI		2
DZJF		62
D5EH	5	49
EFLY		32
ELKX	15	11
GZIX	43	26
JHJZ		43
KAPD	1	59
KHLZ		11
KSLH		28
LCFE		1
LNDL	25	134
[illegible]		23
SGPY	8	8
S6FY		58
WEVI		41
WLIP		9
WSNH	20	44
XCPV	62	46
ZCUT	62	79
3FXS	16	17
5MTY		32
6ZQJ		1
9VPU	44	73
9VXB	22	52
MAUMEE	39	65
MEDIA	38	109
MIDAS RHEIN	12	54
MING YOUNG	18	31
MOBIL POWER	37	88
MOBILGAS	20	55
MONMOUTH	3	33
MORMACARGO	6	39
MORMACSAGA	3	43
MORMACTIDE	29	97
MOUNT RAINIER	11	
NATIONA	1	
NEW ENGLAND TRAPPER		139
NOPAL BRANCO	25	34
NORDBALT		10
NORSE PILOT	17	
OCEAN DUKE	8	
OCEANOGRAPHER	68	74
OGDEN JORDAN	15	
OGDEN WABASH	13	
OLGA TOPIC	19	
ORCO TRADER	76	61
ORIENTAL COMMANDER	9	39
ORIENTAL LEADER	36	140
OVERSEAS ALEUTIAN	27	54
OVERSEAS JUNEAU	42	125
OVERSEAS VALDEZ	1	
PACBARONESS	1	
PACIFIC ACE		57
PACIFIC VENTURE	52	91
PACMERCHANT	15	36
PACSTAR	15	36
PARALLA	22	54
PAYSANDU	49	
PENNSYLVANIA SUN	1	19
PINE LIGHT	7	
PIONEER CONTRACTOR	16	78
POLAR STAR WAGB-10	75	
PRESIDENT ADAMS	18	28
PRESIDENT HARRISON	8	
PRESIDENT KENNEDY	45	98
PRESIDENT PIERCE	70	121
PRESIDENT TAYLOR	6	49
PRINCE WILLIAM SOUND	32	127
PVT JOHN R TOWLE	6	
QUIXADA	1	
RED JACKET	18	61
RESOLUTE WPC 620	8	
RIO OLIVIA	22	24
ROMANDIE		21
ROYAL VIKING SKY	74	103
S P LEE	12	
SAMOA	46	83
SAN FRANCISCO	34	92
SANKOGRAIN	7	
SANTA CLARA	28	87
SANTA MARIA	14	25
SEA FAN	16	20
SEALAND ECONOMY	20	121
SEALAND MARKET	4	37
SEALAND TRADE	54	75
SEATRAIN BUNKER HILL	101	185
SEATRAIN VALLEY FORGE	1	
SEPTA	17	44
SHING ON	29	
SINCERE NO 5	2	25
SNOWLAND	12	43
SONGKHLA	41	99
STAR HONGKONG	11	
STOLT LLANDAFF	27	8
STREAM HAWSER	9	
SUGAR ISLANDER	22	106
SUSQUEHANNA	9	57
T F L LIBERTY	31	103
TAIWAN PHOENIX	9	15
TAMPA	34	107
TASMANIC	3	21
TAMPA	34	107
TEXACO NEW YORK	18	12
THOMAS G THOMPSON	2	
THOMAS NELSON	6	12
TOBIAS MAERSK	4	34
TONAMI MARU	87	9
TOYOTA MARU 12	60	27
TRANSCOLORADO	24	88
TRINITY	45	126
TSUI YUNG	1	
UNION CONCORD	29	
UNITED SPIRIT	3	
VALLEY FORGE	7	
VAN TRIUMPH	9	57
VICENTE GUERRERO	16	
VIOLET	50	79
WASHINGTON RAINBOW		64
WESER EXPRESS	80	99
WILMINGTON GETTY	47	113
WORLD SUPREME	13	
YUKON T-AO 152	44	
ZIM NEW YORK	20	30
ABWB	15	97
D5AO	20	32
D7PI		9
ELFD	7	26
ELPA	25	41
HPHI		32
JJBD	10	16
KGSB		76
KNBA		19
KSLJ		135
LCPZ	45	87
LRRT	10	11
NTRI	2	115
SHTS		1
S6HZ	71	91
WFGU		9
WNVN		14
WYS3261		92
XCTE	6	80
3EBA	5	11
5LCJ		12
5MUE	11	13
6ZVK		33
9VPV	49	164

SUMMARY: GRAND TOTAL VIA RADIO 24040 GRAND TOTAL VIA MAIL 49437

Rough Log, North Atlantic Weather

February and March 1979

ROUGH LOG, FEBRUARY 1979--The storms this month were large and deep as would be expected in a winter month. There were two especially vicious storms that affected land areas--the east coast of the United States and central Europe. The storms generally followed climatology, moving from the Great Lakes into the Labrador Sea and off the U.S. East Coast toward Iceland. Generally, high pressure protected northern Europe, but one bad storm moved in on a more southerly track than usual. Another hugged the U.S. East Coast and produced havoc with heavy snow.

The Icelandic Low was 992 mb this month and over 400 mi south of its climatic position. This was 11 mb lower than its normal 1003-mb mean central pressure. A secondary 1004-mb Low was normally located off the northwest coast of Norway. The 1023-mb Azores High at 29°N, 20°W, was 10° longitude east of its normal 1020-mb position. There was sharp troughing off the U.S. East Coast as normal, with an additional trough over the central ocean at about 40°W. The large High over northwestern Canada extended its influence into the eastern United States.

The major anomaly and the one that dominated most of the Atlantic north of latitude 30°N was minus 16 mb near 47°N, 37°W. There was a plus 4-mb anomaly over the North Sea and a plus 3 mb near the Canary Islands. The pressure anomaly over the eastern United States ranged from plus 8 mb over the Great Lakes to plus 2 mb over Florida. The pressure over the Mediterranian Sea was as much as 7 mb below normal near Sardenia. It was also as much as 8 mb below normal over the central ice cap of Greenland.

In the upper air at 700 mb the major Low was 86 m deeper than usual near its normal position of 75°N, 85°W. There was a second abnormal closed circulation between Belle Isle and Kap Farvel. The major long-wave trough was over midocean near 45°W, rather than along the North American east coast. The ridge over the west coast of Europe was accented.

Extratropical Cyclones--During the first week of this month, the Atlantic was dominated by a large severe storm that had originated in January. It is described in the January Rough and Smooth Logs. That low center dissipated over Newfoundland on the 7th.

This LOW formed in a trough of the above storm and was first analyzed on the 0600 chart of the 6th near 41°N, 52°W. At 1200 its existence was noted by the high wind and wave reports from the OIHZ (70 kn) and the SALLAND (60 kn and 49 ft). Other ships also reported extreme winds and waves. The CHAMPLAIN (38°N, 62°W) had 65 kn and 49 ft, the EXPORT CHAMPION (39°N, 64°W) had 60 kn and 33 ft, the GOLDEN DOLPHIN (39°N, 60°W) had 50 kn and 39 ft, and the KIMITSUSAN MARU (34°N, 64°W) found 40 kn and 44 ft. By 1200 on the 7th this 965-mb LOW was near 46°N, 44°W. The highest wind report was 91 kn by the AMSTELBRINK near 40°N, 51°W, and the highest wave was 43 ft reported by the SALLAND (35°N, 53°W). Several ships had 39-ft waves (fig. 66).

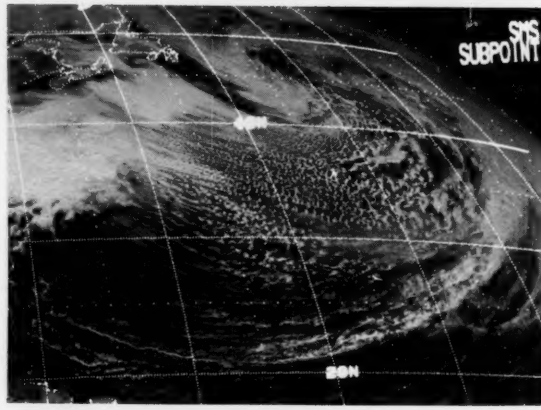


Figure 66. --At 1700 the LOW was east of Cape Race. The clouds indicate cyclonic circulation as far south as 20°N. Another storm is moving off of Cape Hatteras.

On the 8th the LOW had two centers, and the pressure had risen slightly to 970 mb. The CARCHESTER (40°N, 42°W) was trying to sail eastward with the storm. She was in a 60-kn wind band with 33-ft waves. The CLYDEBANK (37°N, 39°W) was sailing westward into 49-ft swells.

The original LOW disappeared as another formed about 300 mi to the south. This became the primary storm after fighting off the formation and invasion of several other LOWs.

At 0000 on the 9th the AMERICAN ARROW with a pressure of 970 mb was within 4 mb of the center of one of the sub-LOWs and had 70-kn winds from the northeast. Winds of over 50 kn and waves of around 25 ft continued. The storm was moving into Europe on the 10th. The swell waves were still reaching 40 ft at times in the southwest quadrant of the storm, and this continued into the 11th. The storm was over the English Channel on the 12th with another rapidly approaching.

The ancestor of this storm crossed the Pacific Coast on the 7th. It weakened considerably as it crossed the western mountains, but then it was reconditioned in the Midwest storm factory with warm, moist air from the Gulf of Mexico. It crossed the Gulf Stream late on the 9th, where additional fuel was added. The northerly flow behind the storm brought extremely cold air over the East Coast (fig. 67). On the 10th the MIROSLAWIEC found 58-kn winds near 35°N, 66°W (fig. 68). By 0000 on the 11th the central pressure had plunged to 942 mb--48 mb in 12 hr. A ship on the east side of the storm had heavy rain, while one on the west side had heavy snow. A Japanese ship about 150 mi south of the center was fighting 60-kn winds and 39-ft swells. Five degrees latitude farther south the ZEALANDIC reported 33-ft waves.

Wind reports of 60 kn and waves up to 30 ft con-

Figure 67.--Cliffs have been cut into ice up to 15 ft thick at Virginia Beach, Va. What looks like a rocky beach is smooth sand at other times. Wide World Photo.

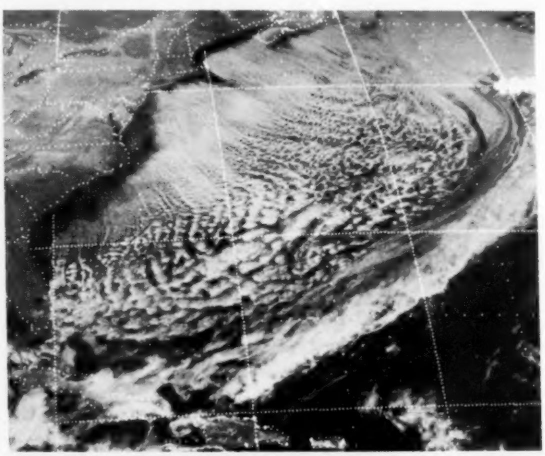


Figure 68.--Cloud streaks indicating cold unstable air pour southeastward over the warm Gulf Stream behind the cold front.

tinued as the storm traveled eastward near 50°N. On the 12th the BOOKER VIKING was sailing with 60-kn winds and 49-ft waves in the vicinity of 43°N, 22°W, while the ATLANTIC PROSPER (48°N, 25°W) sailed westward almost across the storm's center with 46-ft waves. Another ship along 45°N had 39 ft. The storm passed north of OWS Romeo, bouncing her with 30-ft waves.

On the 13th the storm moved into the English Channel. Another LOW had formed east of Belle Isle which produced a long sausage-shaped area of low pressure from coast to coast between 50° and 55°N. North of 55°N the winds were easterly, and south of 50°N they were westerly with a long fetch. This produced high waves of 20 to 30 ft, especially south of 50°N. This circulation broke down on the 14th as new LOWs formed, changing the pattern and easing the weather over the sea lanes for a few hours.

This did not help northern Europe. The original LOW dissipated over Germany late on the 14th, and another which had formed off Cabo Finisterre moved inland. Blizzard conditions hit northern Europe on the 15th. Denmark and the Netherlands were especially hard hit. Four fishing trawlers sank from the heavy ice and seas, and the crewmen drowned. The 12,458-ton French FRANCOIS VIELJEUX sank near Vigo, Spain. The 41,964-ton Greek CHRISTINA II reported heavy-weather damage at Tenerife on the 18th while on a voyage from Libya. Storm-force winds kept the temperatures near minus 40°C at midday in Sweden and Denmark (fig. 69). At least 58 deaths were attributed to the cold. All transportation was at a standstill. In the south heavy rains caused floods and landslides in Italy. In Greek harbors the authorities banned all ships under 2,000 tons from sailing in the Aegean and Ionian Seas because of high winds. Heavy seas battered the Portuguese coast after the worst floods for more than a century. About 10,000 people were evacuated from flooded homes. Winds up to 90 kn hit the Oporto area, damaging the port terminal at Leixoes. An oil complex was damaged also as was the main hotel in the fishing village of Ericeira north of Lisbon. The storm finally moved over the Mediterranean Sea and relieved northern Europe.

This was one of the LOWs that helped to break down the long fetch and high waves of the storm above. It was first found on the 1800 analysis of the 14th south of Cape Race at 40°N. The BARWA immediately had 60-kn winds and 20-ft seas from the south as the gradient tightened between this LOW and the stationary Azores High. OWS Lima, still in the easterly flow, had 34-ft waves.

At 1200 on the 15th the 981-mb LOW was near 48°N, 40°W. The EXPORT FREEDOM at 38°N, 45°W had 33-ft swells from the southwest. The circulation was now circular. The LOW was traveling northward on the 15th and passed within a few miles of OWS Charlie. At 0000 of the 16th he measured 58-kn winds and 30-ft seas. Lima had 57 kn and 20 ft. By 1200 the 966-mb storm was near 60°N, 36°W. Both Charlie and Lima continued to measure 50- to 60-kn winds and 30- to 36-ft waves. The LOW crashed ashore on southern Greenland. At this time an immense 1050-mb HIGH centered over the Great Lakes dominated the United States, except for states along the Pacific coast.

Figure 69.--The icebreaker STETTIN pours off black smoke as she and five others struggle to free up to 80 freighters caught in ice on the Baltic Sea. Wide World Photo.

Figure 70.--All the Lakes were frozen over on the 17th. This was a first as far as can be determined from modern records.

Record cold temperatures caused the Great Lakes to freeze over (fig. 70). Temperatures as low as minus 47°F were recorded in New York State. These same cold temperatures stemmed the flow of coal through Baltimore as it froze in the cars. Bulkcarriers were delayed as long as 3 weeks. Ice on the Chesapeake Bay ranged from 4 to 15 in with rafted ice as much as 6 ft.

As the LOW described above died over Greenland, other LOWs were forming in the overall circulation. A small wave was moving northward up the cold front. The PIONEER COMMANDER was broadsided by 34-ft swells as she headed toward Fastnet Rock. On the 18th another LOW formed near the center of this immense cyclone near 54°N, 38°W. There was another small closed circulation at 40°N. OWS Charlie measured 50-kn winds and 25-ft seas. The LOW was analyzed as 958 mb and Charlie registered 965 mb. Far to the south (34°N, 54°W) the BARWA reported 60-kn winds. On the 19th several ships, including the AMERICAN ARGOSY, had winds over 50 kn and seas of 30 ft. Ocean Weather Stations Charlie and Lima were still being bounced by waves over 20 ft. This storm also grounded on the Greenland shore.

Atlantic Monster of the Month--A frontal wave formed over the Gulf of Mexico on the 18th and crossed over Florida to the Gulf Stream. The large HIGH that was over the Great Lakes was moving off the coast near Cape Cod. This set up the ideal situation for a blizzard on the U.S. East Coast. And this is just what happened. The LOW was diverted up and parallel to the coast, feeding moisture-laden air over a very cold surface layer. At 1200 on the 19th the 1004-mb LOW was off Norfolk, Va. A Navy ship (37°N, 74°W) re-

Four ships reported winds over 70 kn, one being preceeded by STORM, so there were no call letters on the chart. The others were the ERIKA JACOB, ERLANGEN, and DON CARLOS (fig. 73).

The storm turned northeastward on the 22d and 60-kn winds continued in all but the northeast quadrant. The STEPHANITOR (38°N, 41°W) about 400 mi south of the center had 49-ft waves. The 13,209-ton Greek STARLIGHT, bound Antwerp for New York, lost 20 40-ft containers overboard late on the 21st when stormy weather broke lashing materials. On the 23d another LOW was moving eastward south of this one and broke up the high wind and wave pattern in that area; but 60-kn winds and 26-ft waves were still occurring west of

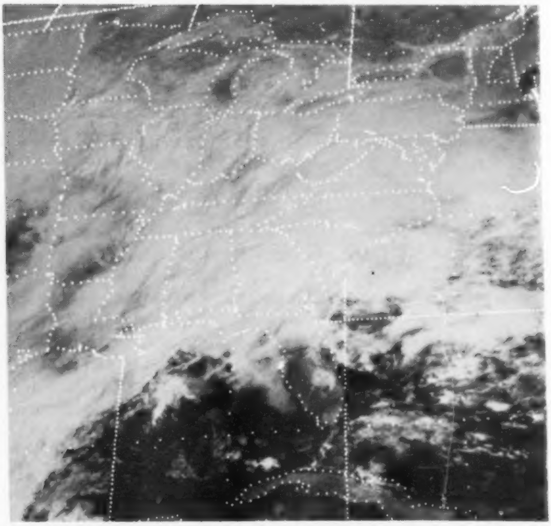


Figure 71. -- The tremendous cloud shield covers the East Coast. It has already started to snow over the Southeast. The weak LOW is off the Georgia coast on the 18th at 1600.

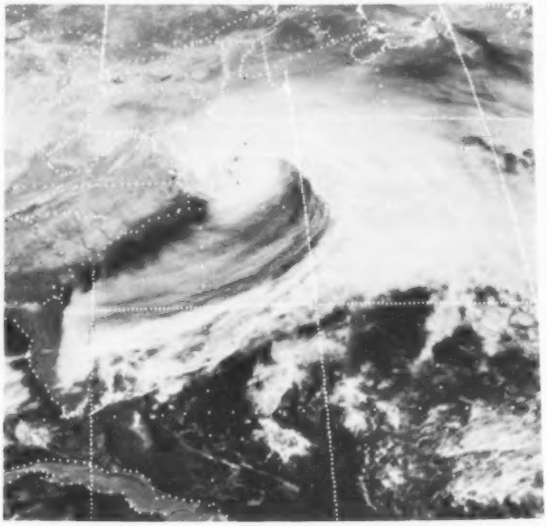


Figure 72. --At 1800 on the 19th the storm has consolidated off Norfolk, leaving a paralyzed East Coast.

ported 75-kn winds.

The snow began early on the 18th in Georgia and the Carolinas, and they received over 10 in. As the storm approached Washington, D.C., it was snowing up to 2 in/h in some places. Accumulations were as much as 2 ft along the seaboard. Washington National Airport had 18.7 in between 4:00 p.m. on the 18th and 11:00 a.m. of the 19th. It was the greatest snowfall in over 50 yr. There were 3- to 5-ft drifts in the metropolitan area, and the entire city was closed for the day. Six major airports on the East Coast were closed, while many others barely managed to keep one runway operational. Some of the major ports were closed or had only limited operations into midweek (fig. 71). Warm air from the Gulf behind this storm brought temperatures above freezing in the upper Midwest for the first time in as long as 60 days in some places.

Late on the 19th the storm turned eastward away from the coast (fig. 72). At 1800 the ATLANTIC CHAMPAGNE was north of the storm's center with 86-kn easterly winds. On the 20th two ships reported winds of over 60 kn in southerly flow with waves up to 33 ft. Another ship north of the center had 55-kn winds and 33-ft seas. The 21st was really a violent day.

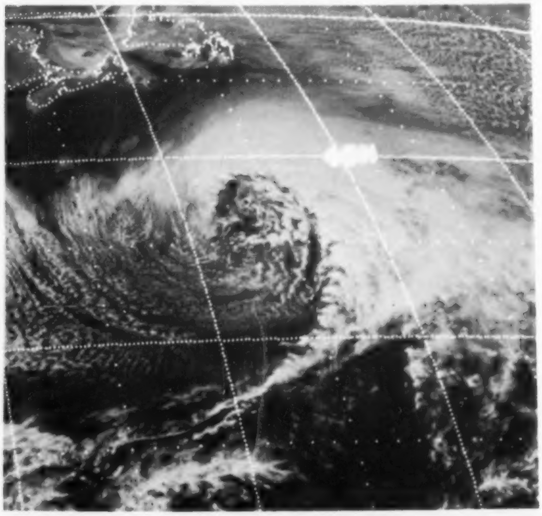


Figure 73. --The violent storm looks very much like hundreds of others.

the center near 50°N. The ATLANTIC CAUSEWAY (14,946 tons) lost two containers overboard during heavy rolling 750 mi east of Halifax, Nova Scotia. The storm passed slightly east of OWS Charlie on the 24th with 45-kn winds and 28-ft seas. Romeo had 33-ft waves. The storm was rapidly weakening and disappeared from the analysis late that day.

This storm was not noted so much for its high winds, but for its high waves, particularly swells reported by Ocean Weather Stations Charlie and Lima. On the 25th a LOW moved across the Labrador Sea. As the front crossed southern Greenland, a new LOW formed off the southeast coast on the 26th. At 1200 on the 27th the LOW was 978 mb over northwest Iceland. Lima reported 40-kn winds and 16-ft swells, while Charlie had 21-ft swells. Later, the swells picked up to 28 ft at Lima.

On the 28th Lima was reporting gales in the 40-kn range and waves to 25 ft. The SEA-LAND PRODUCER found 40-kn winds and 21-ft swells with a thunderstorm west of Bishop Rock. On the analysis of March 1, the storm had split into three centers with the original one turning northward over the Greenland Sea. Later, another moved south of Iceland.

This storm formed over the Gulf Coast late on the 24th. The OVERSEAS ALEUTIAN was south of Port Arthur sailing westward with 40-kn northwesterly gales on the 26th. The DELTA AMERICAN was off Cape Hatteras with 40-kn southerly gales. Both ships had 15-ft waves. The LOW crossed the coast near New York early on the 27th. The SEA-LAND VENTURE was near 34°N, 66°W, slightly east of the front at 1200, with 45-kn gales and 23-ft waves. On the 28th the storm moved up the Bay of Fundy and on March 1 joined the larger circulation of the previous storm while over the Labrador Sea. By 1200 the LOW had raced to midway between Kap Farvel and Iceland at 974 mb. The CAPE ROGER (50°N, 50°W) found 42-kn northwesterly gales and 18-ft waves. On the 2d the KAPITAN NOCHRIN (52°N, 44°W) had 50-kn winds on her port beam. A ship near 52°N, 20°W, was pounded by 25-ft waves. Charlie was tossed by 30-ft waves.

The 968-mb storm center was over Iceland at 1200 on the 3d. Lima was battling 58-kn winds and 33-ft waves. Others south of the storm had 25- to 30-ft waves. An English ship near 58°N, 11°W, had 70-kn winds with 43-ft waves, and a U.S.S.R. ship near 59°N, 02°E, had 85-kn winds and 25-ft waves. On the 0000 observation of the 4th a Norwegian ship reported 77-kn winds in the same area. By the 1200 chart, only a trough remained.

Casualties--The bulkcarrier POLLUX, Liverpool for Jacksonville, arrived St. Michaels on the 17th with heavy-weather damage. The 3,052-ton Panamanian DOXA arrived Columbia with heavy-weather damage. The 3,094-ton French ferry SAINT GERMAIN and the 14,493-ton Liberian freighter ARTADI collided in the English Channel in heavy fog about 4 mi off the French coast. Two people were killed and four injured.

On the 23d there were 17 vessels waiting to enter the Port of Corpus Christi, Tex., because of heavy fog.

The 103,907-ton American tanker BROOKLYN was at Malta on the 25th with no engine power awaiting parts. Gale- to storm-force winds resulted in her dragging anchor.

ROUGH LOG, MARCH 1979--The climatological tracks for storms this month primarily are from over the Great Lakes to up the St. Lawrence River to Greenland, where they split to the north and east. A second track is from the U.S. East Coast northeastward. There are secondary tracks across northern Europe and the Mediterranean. The actual tracks this month were similar. The low-pressure centers from the Great Lakes generally tracked into Baffin Bay with another center forming near the southeast coast of Greenland and tracking east to northeastward. More than the usual number of East Coast storms turned northward toward the Labrador Sea. The secondary tracks out of the eastern ocean combined into a primary track across central Europe.

There were major differences between the climatic and actual mean monthly pressure patterns. The one that had the most effect on the shipping lanes was the location of the Icelandic Low. This month it was 994 mb between Iceland and Norway near 67°N, 02°E. It is normally 1005 mb near 58°W, 40°W, off Kap Farvel with a companion 1007-mb LOW near the actual location this month. The Azores High was 1025 mb near 37°N, 27°W, about 800 mi northeast of its normal 1020-mb position. There was an anomalous closed 1021-mb High off the U.S. southeast coast. The Arctic High over the Arctic Ocean at 1041 mb was 18 mb higher than the climatic normal. This did not directly affect the weather over the North Atlantic, but indirectly it had to have a great influence.

With such large differences in central pressures and locations, there were bound to be large anomalies. The Icelandic Low produced a minus 15-mb center off Norway. The displacement of the Low and the Azores High combined to produce a plus 16-mb anomaly center near 48°N, 40°W. The Arctic High produced a plus 21-mb center that stretched deep into Siberia.

At 700 mb the primary Low center was normally located near Baffin Island only 61 m deeper than normal. The surface Low over the Norwegian Sea was reflected by a secondary Low near 69°N, 05°W. There were two long-wave troughs, one off the North American coast and another over the west coast of Europe. The midocean was dominated by a ridge. The anomaly centers were collocated with their surface counterparts.

Extratropical Cyclones--This LOW center formed on the 4th off the southeast coast of Greenland in a trough of the general cyclonic circulation. There was very little change in the westerly flow that had prevailed for several days. A Soviet ship west of OWS Charlie had 45-kn winds, while Charlie had 26-ft swells. By 1200 on the 6th the storm had moved to 63°N, 05°W, at 970 mb. The ocean weather stations had winds of about 40 kn and seas and swells up to 25 ft. A Norwegian ship on the North Sea had winds over 50 kn, and nearby a Russian ship reported 30-ft seas and 38-ft swells. The storm was running northeastward along the Norwegian coast late in the day and passed almost directly over OWS Mike. At 0000 on the 7th Mike had 40-kn winds and 20-ft seas. On the 8th the storm continued past Nordkapp.

Figure 74. --The outline of Iceland can be determined through the clouds with some concentration. Shelf ice off Greenland reaches nearly to the northwestern tip of the island.

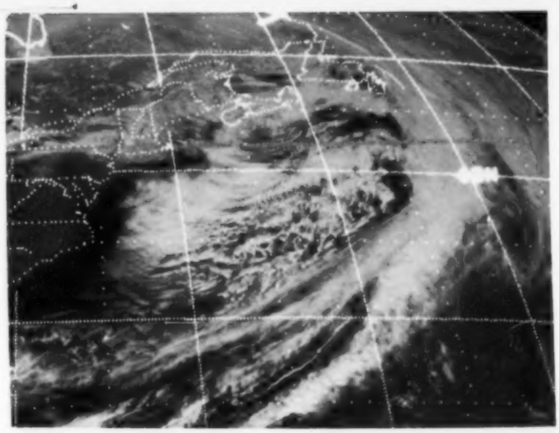


Figure 75. --The LOW is over the Gulf of St. Lawrence at 1800 on the 12th, but the heavy weather was south of the Maritime Provinces.

This was another of those storms that split on the southern tip of Greenland. The original LOW came across Hudson Bay and at 1200 on the 6th was against the southwest coast of Greenland. The storm split by the 7th, with one center moving northward up the west coast and the other center forming on the southeast coast. This new center was 978 mb. The Icelandic fishing fleet reported winds up to 50 kn. A buoy off the southwest coast of Iceland measured 40-kn winds.

At 1200 on the 8th the tightly wound storm was 956 mb over Iceland (fig. 74). A U.S. Navy ship north of Ireland had 58-kn winds. A Canadian ship near 56°N, 27°W, also had 60-kn winds. Lima reported 23-ft swells. On the 9th Lima measured 55-kn winds and swells to 33 ft. The reporting platforms in the North Sea were battered by winds up to 45 kn and seas up to 25 ft. The IRVING ARCTIC (50°N, 04°W) reported 30-ft seas and 49-ft swells. On the 10th the storm circled northwestward into the Greenland Sea and returned to the Greenland coast. The Scoresby Sound station measured 40-kn freezing winds.

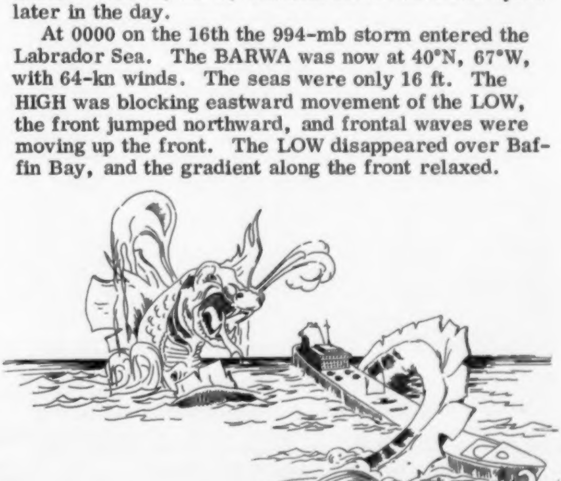
A frontal wave moved over the Maritime Provinces on the 8th. On the 9th another wave formed on the front farther east. The STUTTGART EXPRESS (49°N, 40°W) was running into 44-kn winds and 23-ft swells south of the wave. On the 10th the storm turned northward in response to lowering pressure to the north. The ATLANTIC SAGA (50°N, 30°W) had rain driven by 50-kn winds with 21-ft seas. On the 0000 chart of the 11th, two LOWs had combined into one and the storm had moved eastward. The pressure was 962 mb at 1200. Lima and ships in that area were again catching the brunt of the storm with winds over 40 kn and seas of 25 ft or over. The RANGA had 60-kn winds south of Iceland. A German ship nearby had 50 kn and 23 ft. The LOW was over the North Sea on the 12th bringing winds in the 40-kn range. The storm moved over the Continent on the 13th.

This storm formed over Maine at the point of occlusion of a front stretching south out of Canada. As the LOW moved northward and the front eastward, the gradient on the east side tightened against a HIGH over the central ocean. At 1200 on the 12th the 958-mb LOW was north of Anticosti Island (fig. 75). The Blue Hill Observatory measured 51 mi/h and Mt. Washington Observatory, N.H., at over 6,000 ft measured 107 mi/h. The WILD CURLEW (40°N, 63°W) reported 50-kn winds and 33-ft seas, while the IMPERIAL ACADIA (46°N, 59°W) radioed 50-kn winds, but neglected the waves.

By midday on the 13th the LOW had reached Frobisher Bay. The ATLANTIC SAGA was southeast of Sable Island with 52-kn northwesterly winds and 30-ft seas. On the 14th the front swept by the HOFSJOKULL (52-kn winds) and OWS Charlie (21-ft waves). The LOW died over Canada, and another formed on the front east of Kap Farvel.

This LOW moved over the Great Lakes on the 13th and 14th. Its eastern circulation was off the coast on the 14th with winds up to 40 kn. On the 15th the BARWA (37°N, 64°W) was in southerly 58-kn winds. The TACTICIAN at 33°N, 66°W, verified the 58-kn wind report later in the day.

At 0000 on the 16th the 994-mb storm entered the Labrador Sea. The BARWA was now at 40°N, 67°W, with 64-kn winds. The seas were only 16 ft. The HIGH was blocking eastward movement of the LOW, the front jumped northward, and frontal waves were moving up the front. The LOW disappeared over Baffin Bay, and the gradient along the front relaxed.



Monster of the Month--These storm reports were involved with a series of small LOWs that formed, rotated around a common center, and dissipated. It started with one of the frontal waves from the previous storm. One of the waves brought 45-kn winds to a Soviet ship near 40°N, 45°W, on the 17th. As that circulation moved northwestward, another formed to the southeast on the 18th. The YTXT near 32°N, 53°W, had 60-kn winds. The LNG CHALLENGER (36°N, 70°W) discovered 53-kn northwesterly winds. The BARWA was still in the area (45°N, 43°W) with 74-kn winds out of the southeast and 36-ft seas (fig. 76).

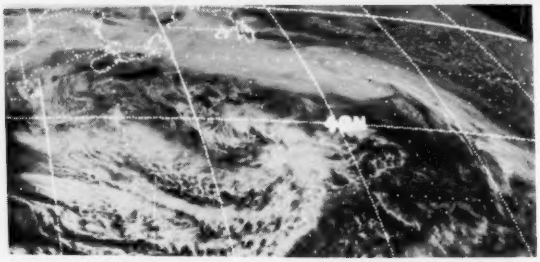


Figure 76.--One LOW near 45°N, 45°W, has a dark spot that looks like a small eye. Another is near 40°N, 57°W, at 1800 on the 18th.

There were three separate small LOWs of about 998 mb on the 19th with centers located from 46° to 35°N and 51° to 61°W. The CGC TAMAROA had 40-kn winds and 30-ft swell waves near 34°N, 67°W. The IMPERIAL ACADIA and another Canadian ship had 60- and 78-kn winds in the vicinity of 47°N, 60°W. The GREEN HARBOUR was near the center of one of the LOWs at 35°N, 59°W, with winds of 50 kn and seas of 16 ft.

These LOWs had very shallow upper air support--a trough at 700 mb--but between the 17th and 19th a LOW at 700 mb plunged from 60°N, 70°W, to 35°N, 60°W, and the surface consolidated into one large LOW on the 20th

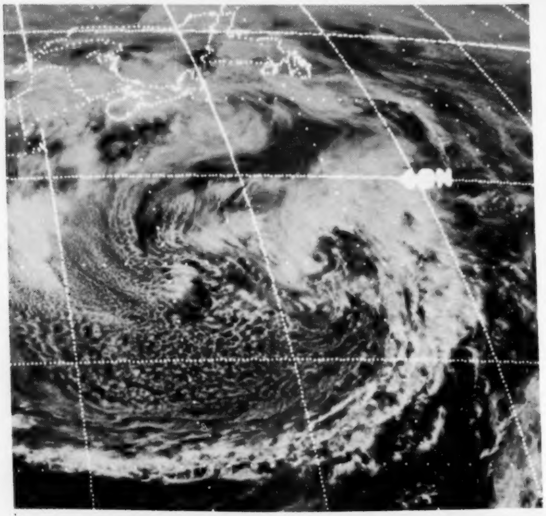


Figure 77.--This satellite image for 1700 on the 19th indicates the consolidation of the storm.

(fig. 77). The higher winds were now above 40 kn. On the 21st a ship near 29°N, 56°W, had a thunderstorm and 28-ft swell waves. On the 22d a ship west of the center had 45-kn northerly winds, and one east of the center had 60-kn southerly winds. The storm was now traveling east-northeastward with only gale reports. At 0000 on the 25th it was 978 mb near Ireland. OWS Romeo had gales with 20-ft seas. The storm slowed as it passed over Scotland. It dissipated on the 27th.

This storm originated over the south-central United States and moved slowly toward the East Coast. Its southerly circulation moved over the Gulf Stream on the 24th (fig. 78). It brought high winds all along the coast. Wallops Island, Va., and Wilmington, N.C., measured 45 mi/h. Blue Hill Observatory, Mass., measured 44 mi/h and the Mt. Washington Observatory, N.H., measured 119 mi/h. The 993-mb center was over Maine on the 26th. Several ships reported winds over 40 kn in the southerly flow. One near the front had 30-ft seas. The DELTA DRECHT had been reporting winds near 40 kn, but they jumped to 78 kn at 1800 near 40°N, 62°W. On the 27th the CG11 near 46°N, 60°W, radioed 60-kn winds. On the 28th the storm crossed into the Labrador Sea and continued up the Greenland coast to oblivion.

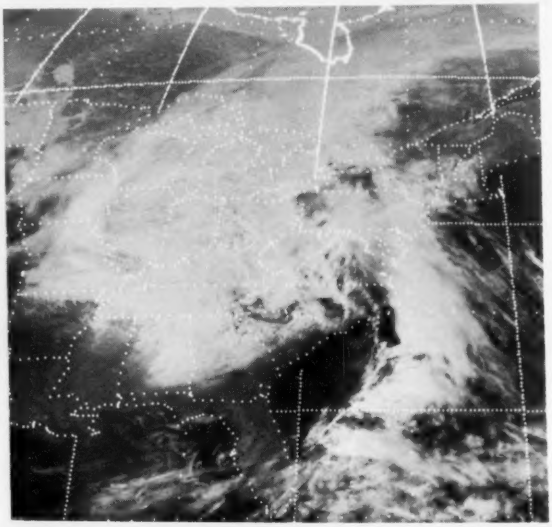


Figure 78.--At 1700 on the 24th the LOW is over Michigan, but the front has moved off the East Coast with very high winds.

Casualties--Melting snow and ice jams flooded many rivers in the Midwest during the month. The Coast Guard cutter SCIOTO (fig. 79) sank on the Missouri River near Leavenworth, Kans. The 13,209-ton Greek STAR LIGHT (fig. 80) and the USS FRANCIS MARION (fig. 81) collided in heavy fog in Chesapeake Bay on the morning of the 4th. Both ships were damaged with two injuries on the Navy ship. The 48,429-ton Liberian tanker MARILIA ran into ice off eastern Canada and was holed in the forepeak.

The 13,326-ton Panamanian STAR SUPREME reported encountering heavy weather with damage to gantry bulwark and containers washed overboard upon ar-

Figure 79.--The Coast Guard cutter SCIOTO is listing among the ice floes on the Missouri River. U.S. Coast Guard Photo.

Figure 80.--According to this picture the STAR LIGHT suffered mostly bow damage. Wide World Photo.

rival at La Pallice, France, early in the month. The cargo vessel FRANZ XAVER KOGEL alleged heavy-weather damage during a voyage from Italy to Puerto Rico. The motor vessel ARROI arrived Balboa on the 13th with cargo shifted during heavy weather.

The 32,531-ton British tanker KURDISTAN (fig. 82) struck an unknown object in Cabot Strait. She broke in two in heavy seas and ice. Forty crewmembers abandoned ship in rafts and were rescued by the Canadian Coast Guard icebreaker SIR WILLIAM ALEXANDER. One lone crewman that had remained aboard was rescued by helicopter. The bow eventually sank in the Atlantic, and the stern was towed to safety for salvage or repair.

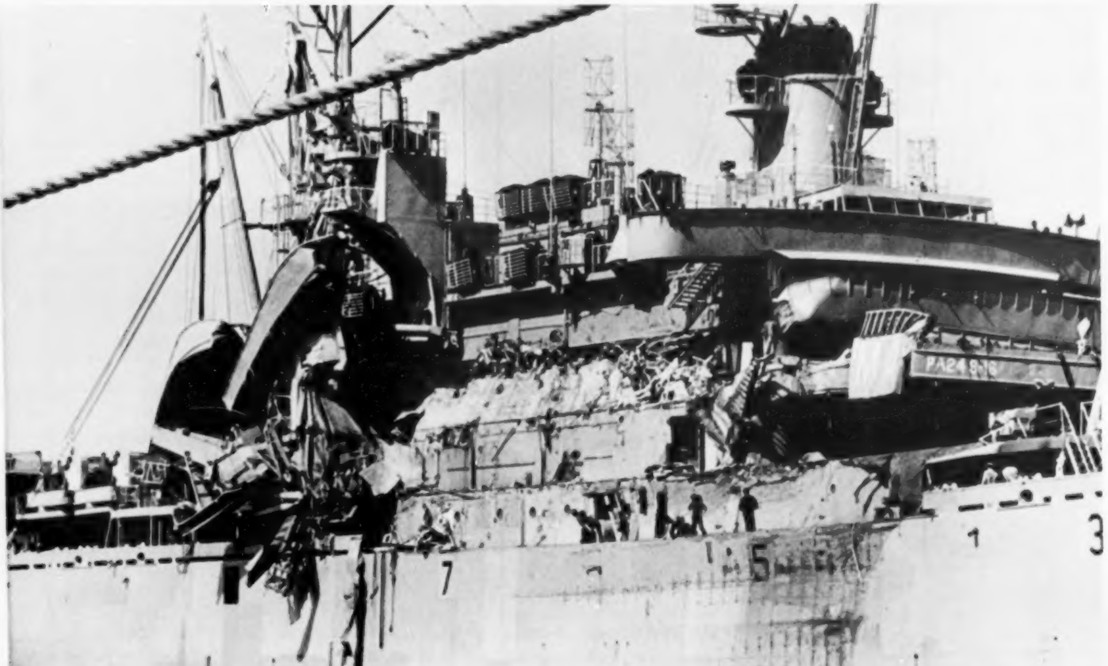


Figure 81.--The U.S. Navy ship FRANCIS MARION is heavily damaged on the starboard side by the collision. Wide World Photo.

The 38,529-ton SEA VALIANT sustained a split in one of her holds during a storm 800 mi north of the Azores on the 19th. The Cypriot DONATA SCHULTE reported heavy-weather damage upon arrival at Barbados on the 27th.

The American yacht COMPASS ROSE capsized in a fierce gale in the South Atlantic between the Falklands and Argentina. She was rescued by Polish vessels.

Figure 82.--The front part of the stern section of the oil tanker KURDISTAN is awash 45 mi north of Glace Bay, Nova Scotia. Wide World Photo.

Rough Log, North Pacific Weather

February and March 1979

OUGH LOG, FEBRUARY 1979--The primary climatological areas for cyclogenesis are east of Japan and midway between Hawaii and Vancouver Island. This month these areas were shifted slightly westward. The primary storm tracks were also shifted to the west. One primary track extended from Japan up the Kurile Islands in the Bering Sea. There was a secondary track from off Japan into the eastern Bering Sea. Most storms that entered the Gulf of Alaska came out of the central ocean north of Hawaii. These were blocked by the anomalous high pressure over Alaska and turned southeastward or dissipated. One vicious storm hit the U.S. West Coast, and high pressure over Alaska in conjunction with several LOWs produced high winds along the south coast of Alaska.

The mean sea-level pressure was near or above normal over most of this ocean except for an area off the North American coast between northern California and southeastern Alaska. The mean sea-level pressure pattern for the month shows two LOWs, a 1002 mb over the Gulf of Alaska and a 1004 mb near the Near Islands. The Pacific High was centered near 30°N, 138°W, at 1024 mb. There was the usual small HIGH near the Great Salt Lake. Of more significance, though, were two high-pressure centers along the Arctic Circle. This is normally an area of high pressure, but this month it was much stronger. There was a 1034-mb HIGH near the Great Bear Lake of northern Canada. There was also a 1026-mb HIGH over northern Siberia.

The anomaly chart showed an elongated positive anomaly center of 16 mb across northern Alaska to the Great Slave Lake. There was a large area of positive anomaly values, with a plus 10-mb center, centered over the northern ocean. The only significant negative anomaly area was off the Queen Charlotte Islands with a 7-mb center.

The upper air flow was quite different from the climatic pattern. Climatology shows a closed LOW over Kamchatka with a ridge off the North American west coast. Between 30° and 50°N the flow is primarily

zonal. This month the long-wave LOW was south of the Taymyr peninsula at 70°N. A trough curved southeastward then eastward from the LOW to near Beringa Island. Another LOW was near Yakutat, Alaska. Between the trough and the LOW an inverted teardrop-shaped HIGH was over the Bering Strait. There was slight ridging over the Rocky Mountains. As at the surface, the height anomalies were mainly positive except off the coast of British Columbia.

Extratropical Cyclones--The first storm of the month only affected the Asian side of the ocean. It was over the Sea of Japan on the 1st. Ostrov Urup measured 45 kn at their station. The KOSMITCHESKI was near Ostrov Simushir with 54-kn winds. The 992-mb storm was tracking northeastward inside the Kurile Islands on the 2d. That day and the 3d Soviet vessels were reporting gales in the 40-kn range with an occasional 50-kn report. The AMSTELVELD found 40-kn gales and 20-ft seas near 47°N, 160°E. The PRESIDENT MADISON was near 50°N, 165°E, on the 4th with 50-kn winds and 30-ft swells. On the 4th the storm crossed into the Bering Sea and dissipated on the 5th.

Pacific Monster of the Month--On the 3d there was a weak LOW over the Gulf of Alaska between two intense high-pressure cells. One HIGH was 1044 mb over northern Alaska, and the other was the 1038-mb Pacific High off California. On the 4th the first LOW dissipated and another formed near Kodiak Island. The Alaska High moved over the Northwest Territories by the 5th and the LOW blossomed. At 0000 it was 972 mb. At 1800 on the 4th a SHIP (53°N, 133°W) had 58-kn winds from the south. On the 5th the AMERICA SUN (51°N, 136°W) and the RAINIER (53°N, 134°W) both had 48-kn winds.

The pressure gradient across southern Alaska was extremely tight. The 4-mb analysis was almost a solid block rather than individual lines. The winds south of the storm were in the 40-kn range with waves up to 20 ft. On the 6th two ships had 25-ft waves on the Gulf. The LOW remained nearly stationary and filled slightly, but the gradient remained tight over the coast.

On the 5th the winds at Valdez were up to 45 mi/h with gusts to 59 mi/h. On the 6th they gusted to 73 mi/h, and gusts of over 50 mi/h continued through the 10th. The average speed was over 20 mi/h (fig. 83). At Anchorage the strongest sustained wind was 41 mi/h on the 7th, with the strongest gust of 62 mi/h reported on the 8th. Flow of oil in the Alaska pipeline was stopped and no tankers were loaded between the 5th and the 9th. On the 12th there were nine tankers waiting entrance to the terminal. Also, ice was building rapidly in Cook Inlet.

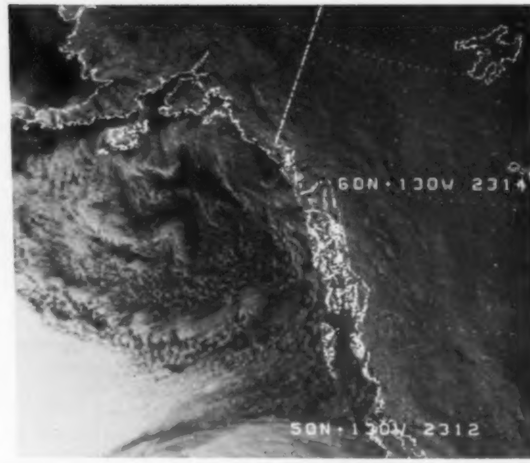


Figure 83.--At least the skies appear to be clear at noon on the 7th when high winds were buffeting the southern Alaska coast. Snow can be seen on the mountains north of the coast.

The winds picked up again on the 14th and 15th. Anchorage had sustained winds of over 50 mi/h with gusts to 64 mi/h on the 14th and Valdez had a 25 mi/h average with gusts to 79 mi/h. On the 15th the gusts were 48 and 62 mi/h, respectively.

This was one continuous storm but not one LOW. The Pacific High vacillated around its position off California and Arctic Highs moved across the north coast of Alas-

Figure 84.--The Hood Canal floating bridge as it appeared before being destroyed by the high winds and waves. The draw span in the middle is open. Wide World Photo.

ka. The original LOW dissipated on the 7th as another formed off Kodiak and drifted across the Gulf at an average pressure of about 998 mb until the 12th. At this time, a strong LOW was moving toward Vancouver Island from its origin near Hawaii. This one moved inland on the 13th (fig. 84). This individual storm is described later. Another LOW developed over the Alaska Peninsula at this time. During this time a HIGH that was up to 1049 mb was crossing the Arctic Coastal Plain of northern Alaska. The gradient along the southern coast remained tight. It was while this last LOW moved southeastward across the Gulf that the high winds had occurred on the 14th and 15th.

Back to the effect of all this on ships. On the 8th a ship south of Kodiak fought 45-kn winds and 30-ft seas. On the 10th the HAKUZAN MARU reported 67-kn southeasterly winds off northern Vancouver Island. On the 14th the ASIA ZEBRA reported 54-kn winds near 54°N, 154°W. On the 15th the U.S. ships MILLER FREEMAN and MOBIL ARCTIC were northwest and north of the center with 41- and 48-kn winds, respectively. At 1800 the ARCO JUNEAU and the PRINCE WILLIAM SOUND were within 30 mi of each other near 56°N, 151°W. Both had 60-kn winds and the later 30-ft seas. Some ships far to the south (latitude 35°N) were finding 40-kn gales and 20-ft waves. Late on the 17th the last LOW disappeared as another approached the British Columbia coast.

This was the LOW mentioned above that originated north of Hawaii. It was first analyzed as a frontal wave on the 11th. The storm steadily intensified as it moved northeastward. At 1200 on the 12th it was 978 mb near 40°N, 137°W. At that time a SHIP had 45-kn winds and 20-ft seas about 300 mi to the southwest. Twelve hours later at 0000 on the 13th the storm was 968 mb near 45°N, 132°W (fig. 85). There were several ships around the storm with high winds and seas. They included: ship - 70 kn, buoy 46002 - 50 kn and 31 ft, SHIP - 36 ft, ARCO JUNEAU - 65 kn and 23 ft, SHIP - 55 kn, 30 ft, and 49 ft.

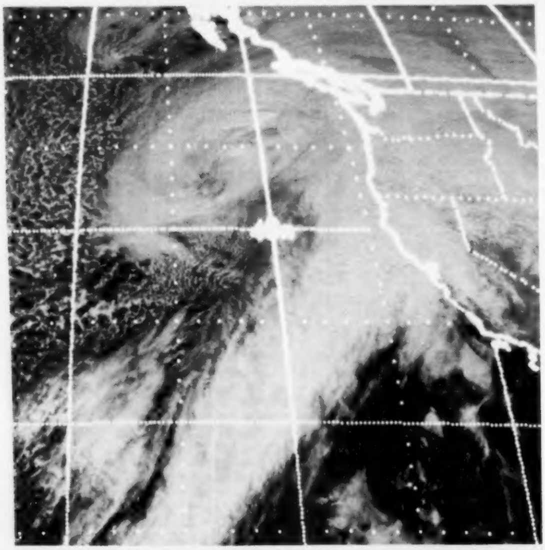


Figure 85. --The vicious storm is shown off the West Coast at 2045 on the 12th prior to moving inland.

At 1200 on the 13th the LOW went ashore at Hecate Strait. Winds up to 50 kn and waves to 30 ft were being reported. Four men were washed off the deck of the 15,067-ton WISTARIA CORAL and a fifth was hurled against a bulkhead and killed off Coos Bay, Oreg. The Hood Canal Floating Bridge at Port Gamble, Wash., had the west section of the bridge washed away (fig. 86) in winds that reportedly reached 100 mi/h. No one was on the bridge at the time. Thousands were without power and two deaths were associated with the storm. Winds and gusts of 50 to 60 mi/h were measured from California to Washington. Cape Flattery recorded gusts to 85 kn. On the 14th the mountains destroyed the storm.

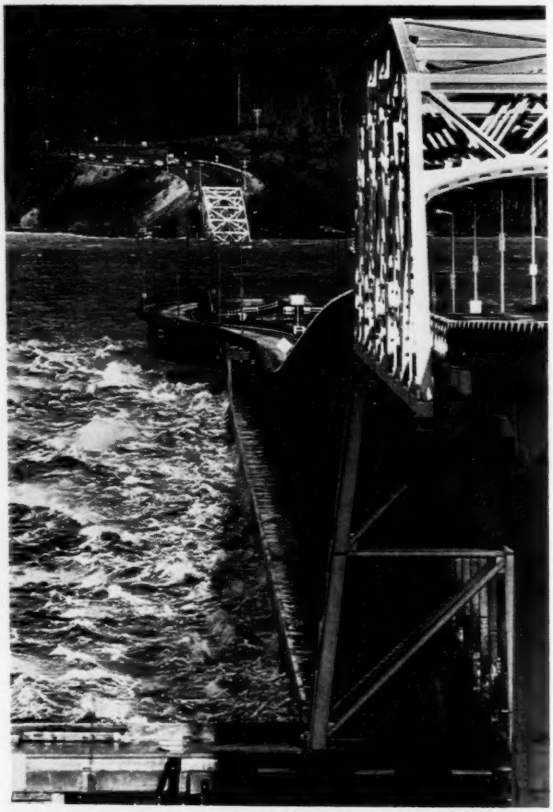


Figure 86. --This view is looking west toward the destroyed section which was torn loose in the 100 mi/h winds. Wide World Photo.

During the first 2 weeks the ocean was occupied by many relatively small storms with winds in the gale category. This storm formed at the occlusion of the front extending from one of these near 45°N, 169°W, on the 15th. The LOW moved eastward pulling its circulation from the last storm over the Gulf of Alaska. At 0000 on the 17th the 988-mb LOW was near 46°N, 144°W. A SHIP (42°N, 147°W) had 54-kn winds and 33-ft swells. Later another had 50 kn and 28-ft swell waves. Late on the 18th the storm bounced off the coast to disappear over the Gulf of Alaska on the 19th.

The Japan Trench off Tokyo was the origin of this LOW on the 15th. It moved northeastward and was 980 mb with 40-kn winds at 0000 on the 16th. Two synoptic charts later showed it was 972 mb along the Kurile Islands. The POUTIVL (42°N, 157°E) radioed 50-kn winds and 18-ft waves. The EDELWEISS reported at 0000 on the 17th with 60-kn winds and 49-ft seas near 48°N, 160°E. The temperature was below freezing. Other ships were reporting 33-ft waves. The storm turned northward and moved over Siberia.

This storm formed farther east than the last one and took a more easterly track. The STAR BULFORD was headed southwestward with 50-kn northwest winds and 16-ft waves pounding her beam on the 19th and 20th. Other ships east of the front found 20-ft waves. The KATORI MARU was in the vicinity of 42°N, 159°E, with 55-kn winds and 33-ft swells for two observations. On the 21st a Japanese ship JRZI had 50-kn winds and 39-ft swell waves near 34°N, 167°E (fig. 87). Another ship (37°N, 172°E) had 25-ft seas and 33-ft swells. The LOW was 976 mb near 48°N, 175°E. By the 22d the LOW was filling rapidly and turning northwestward.

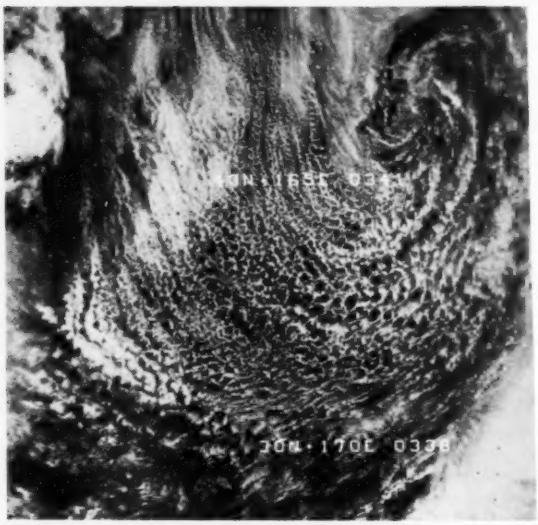


Figure 87.--Early on the 21st the storm was near 45°N, 175°E. The cell-type clouds are indicative of rough unstable weather.

This storm tracked across northern China and crossed into the Sea of Okhotsk on the 21st. On the 22d it hit a group of Soviet ships among the Kurile's with winds up to 56 kn. One of the islands measured 45-kn winds, and a ship along 40°N had 26-ft waves. At 1200 on the 23d the storm was 975 mb near 52°N, 168°E. South of the center the SUCCESSFUL VENTURE (49°N,170°E) had 50-kn winds and 23-ft waves. Much farther south the SHUKO MARU (43°N,160°E) had 33-ft swell waves. On the 24th the storm stalled near 53°N,170°E.

This LOW formed and was analyzed on the 25th with the information from two ships and two island stations. The ships were only reporting 10-kn winds and had good weather. At 1200 on the 27th the 986-mb LOW was near 37°N,150°E. The SEATRAIN CONCORD in the southwest quadrant had 40-kn winds and 26-ft waves. The ATLANTIC NEPTUNE was south of the center on the 28th with 25-ft waves. Southwest of the center many ships reported winds between 40 and 50 kn and waves to 25 ft. The ECKERT OLDENDORFF had 60 kn and 31 ft at 1800. The HEREFORDSHIRE (31°N,152°E) was pounded by 33-ft swells on March 1.

The storm was increasing in size and was the only major circulation across the western half of the Pacific. Waves in the southern half of the circulation were 20 to 26 ft. On the 4th the STREAM HAWSER near 33°N,180°, was sailing into waves up to 36 ft. The LOW had now split into three separate centers, and the original one was lost on the analysis at 1200.

Casualties--The 21,475-ton American PRESIDENT PIERCE at Kobe on the 23d reported heavy-weather damage. The 14,531-ton Liberian-registered COSMOS GIENAH arrived Kobe from San Francisco on the 26th with heavy-weather damage to a hold cover. The Chilean motor vessel AYSEN sustained heavy-weather damage February 27 to March 3 on voyage Long Beach to Yokohama.

ROUGH LOG, MARCH 1979--Sometimes it's surprising how close the average monthly storm paths match the climatological paths. The majority of the low-pressure centers this month were weak and diffuse with short lives. Many dissipated rapidly with a new one forming to take its place. This is what the climatological tracks indicate. This month the primary area of cyclogenesis was near Japan. The storms took two primary paths, one along the Kurile Islands and the western Bering Sea, and the other more eastward to midocean where high pressure off the U.S. West Coast deflected them northward into the eastern Bering Sea. A significant number of LOWs entered the Gulf of Alaska, but they were generally secondary LOWs that formed or broke away from the primary storms. A few storms sneaked south of the high pressure to the California coast.

The Aleutian Low was located near its normal sea-level climatic position at 50°N, 170°E. Its pressure was 996 mb versus the climatic 1005 mb. A climatic 1007-mb Low over the Gulf of Alaska was represented by a trough. The Pacific High was within 1 mb and a few miles of its climatic counterpart. The Arctic High over the Arctic Ocean was 1041 mb, 18 mb higher than climatology. The 45-mb pressure difference between the Aleutian Low and the Arctic High produced a gradient more than twice its normal strength of 18 mb.

The primary anomaly center that affected the marine weather encountered by ships was minus 11 mb near 47°N, 175°E. The other significant anomaly was plus 21 mb with the Arctic High centered near 80°N, 130°E.

The mean 700-mb height pattern differed radically only over the Arctic Ocean where a closed High replaced only climatic ridging. The Aleutian Low was 38 m deeper and shifted east of the Kamchatka peninsula, rather than west as shown by climatic charts. Even with the closed High over the Arctic, the usual ridging over the North American west coast was near normal. As at the surface the two primary anomaly centers were near their pressure centers. Different from sea level and probably significant was a plus 48-m anomaly centered over Dixon Entrance.

Figure 88.--This image on the 5th indicates the storm had moved about 180 mi in 5 hr.

Extratropical Cyclones--This LOW developed in an inverted trough south of Kobe on the 3d. On the 4th the LING YUNG was north of the storm with heavy rain and 26-ft swell waves. By 0000 on the 5th the 980-mb storm was near 33°N, 150°E (fig. 88). Three ships reported winds of 60 kn or more north, west, and south of the center. The ASIA MARU had 65 kn with 33-ft waves on the 982 isobar. The LING YUNG was still north of the storm with only 48-kn northeasterly winds, but she was calling the seas 49 ft and the swells 66 ft. The FEDERAL SUMIDA (28°N,148°E) reported 46-ft swell waves. On the 6th the LOW was racing eastward along 35°N. The MAYA PIONEER felt the sting of 65-kn winds 300 mi south of the center and nearby the STREAM HAWSER had 30-ft waves crashing on her bow. On the 7th the storm had raced past the PRESIDENT TAFT and another ship treating them to 55-kn winds and waves of 25 ft. A ship in the southeast quadrant had 33-ft waves. At 1200 the occlusion passed the CGC SEDGE, which was sailing southward into 55-kn winds and 17-ft seas.

The storm was traveling northward on the 8th at 960 mb near 49°N, 159°W. The higher winds and waves were 40 to 50 kn and 25 to 30 ft. The storm was weakening as it neared the Alaska Peninsula and disappeared over the Bering Sea on the 11th.

A sharp trough moved across Japan on the 5th and 6th. A LOW had formed off Hokkaido on the first chart of the 7th. By 1200 winds over 40 kn were blowing in the southwest quadrant. The LING YUNG was now caught in this storm and had 26-ft seas and 33-ft swells on the 8th. The JUJO MARU No. 2 (44°N, 170°E) had 57-kn winds and 30-ft waves. The high waves continued for the next 30 hr. At 1200 the LOW was 972 mb near 48°N, 170°E. The storm started weakening on the 10th and quickly dissipated.

This LOW crossed the Sea of Japan on the 10th. Immediately after the center crossed Hokkaido the storm intensified. Japanese and Soviet ships near the Kurile Islands registered 40- to 50-kn winds. One, the GVARDEISK south of Ostrov Iturup reported 60-kn northerly winds and 20-ft seas. By 1200 on the 12th the storm

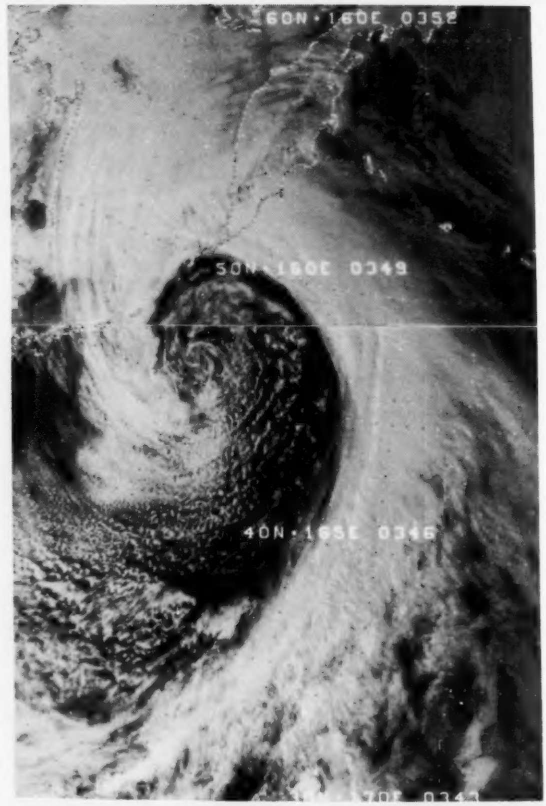


Figure 89.--The cloud mass rotating around the west to southwest side of the LOW usually indicates an area of high vorticity advection, which produces high winds and turbulence.

was 960 mb near 50°N, 158°E (fig. 89). The weather station on Ostrov Urup measured chilling 55-kn winds at -9°C. At 0000 on the 12th there were 35 ship reports of winds 40 kn or greater in the vicinity of the storm. The SANKOSTAR and WAKASUGISAN MARU both reported 33-ft waves. The VANGUARD (43°N, 151°E) reported 60-kn winds and 36-ft waves. At 0600 the PRESIDENT TAYLOR near 41°N, 148°E, was hammered by 60-kn westerly winds and 49-ft seas and swells.

The storm must have chased many of the fishing vessels into port as the number of reports dropped on the 13th and 14th. The VAN ENTERPRISE (42°N, 156°E) had 68-kn winds at 0600 on the 13th. These dropped to 40 to 50 kn on the 14th. The storm was moving up the Kurile Islands and no longer existed on the 16th.

As the storm above moved up the Kurile Islands a frontal wave formed near the Bonin Islands on the 12th. The upper air LOW was associated with the older surface LOW, and this wave was under the influence of zonal flow aloft and traveling eastward parallel to latitude 30°N. On the 13th the PRESIDENT ROOSEVELT was north of the incipient storm with 30-ft northerly swell waves from the older storm. By 1200 on the 14th the storm was 984 mb near 34°N, 169°E. A ship west of the center had 50-kn winds from the north with 20-ft seas and 23-ft swells. The SANKOSTAR was

caught by this storm on the 15th near 40°N, 179°W, within 6 mb of its center with only 40-kn winds but the seas were 26 ft and the swells 39 ft from the south. The storm on a northerly track crossed the eastward course of the PRESIDENT ROOSEVELT and left behind 50-kn winds and waves of 28 ft.

At 0000 on the 16th the storm was 960 mb near 49°N, 178°W (fig. 90). The JGPE was 300 mi to the south with 60-kn winds. No one ventured out to estimate the waves. The storm dissipated near the Shumagin Islands on the 17th.

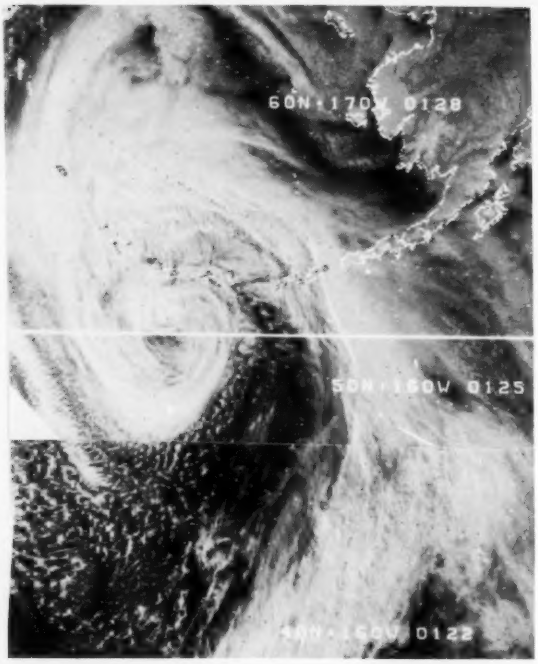


Figure 90.--Many factors that are difficult to measure influence the life cycle of a storm. This image gives little hint that in about 36 hr it will be gone.

This storm was born over the East China Sea about 36 hr after the previous one. It followed a more east-northeasterly track. On the 16th there were a few 40-kn wind reports with 15- to 20-ft waves. By the 17th the LOW was 954 mb near 44°N, 172°E. The PAPYRUS MARU (46°N, 169°E) about 120 mi northwest of the center had heavy snow, 45-kn winds, 26-ft seas, and 33-ft swells. The ASIA ZEBRA was near the point of occlusion with 26-ft waves. The DAIRIN MARU was sailing eastward as the storm traveled northeastward and had winds of 60 kn or more for over 24 hr. Her waves were running about 25 ft and the highest wind was 70 kn near 42°N, 172°E. The WESTOCEAN found 38-ft waves. This storm was absorbed by an approaching storm on the 19th.

This storm came out of Manchuria and was over the Sea of Japan on the 16th and 17th. The BISCAY MARU found 50-kn winds on the 18th at 35°N, 152°E. The MAERSK CADET was nearby (35°N, 150°E) with 50-kn winds and 33-ft seas and swells. At 1200 the SHINZUI MARU (44°N, 154°E) was about 150 mi south of the 976-mb storm with 60-kn winds. On the 19th several other ships had winds near 60 kn with waves up to 25 ft. By the 1200 chart this storm had absorbed the previously described storm. The GARDENIA was on the southwest edge of the circulation traveling with the storm. For 24 hr, 0600 on the 19th to 0600 on the 20th, along latitude 35°N from 156°E to 162°E she had three observations with waves over 50 ft. All portions of the observations appeared good and fit the analysis. At 0000 on the 20th the WORLD FINANCE (40°N, 170°E) verified with 41-ft waves. The storm was now 968 mb near 50°N, 180°, and moving northward into the Bering Sea (fig. 91). It filled rapidly.

Figure 91. --The storm center is over the Aleutian Islands bringing the usual rough winter weather.

This storm crossed Japan on the 24th as tropical storm Bess moved northeastward out of the Tropics (fig. 92). Ships east of Japan were caught by 40- to 45-kn winds. Bess fed warm moist air northward east of the front bringing heavy rain. At 1200 on the 25th, Bess was rated a tropical storm near 26°N, 148°E. By 0000 on the 26th there was no indication on the analysis she existed, but she had fed vast amounts of energy into this extratropical storm. At this time it was 970 mb near 46°N, 154°E. The HARFLEET (41°N, 149°E) and the RYOKO MARU (42°N, 154°E) both had winds over 50 kn and swell waves of 39 ft. Others were generally reporting 20 ft.

On the 27th the LOW was 978 mb near 49°N, 165°E. A Korean ship near 43°N, 160°E, reported 39-ft waves. A ship in the same relative position to the center had 33-ft swells on the 29th. The storm was curving westward, then southwestward, and disappeared on the 30th.

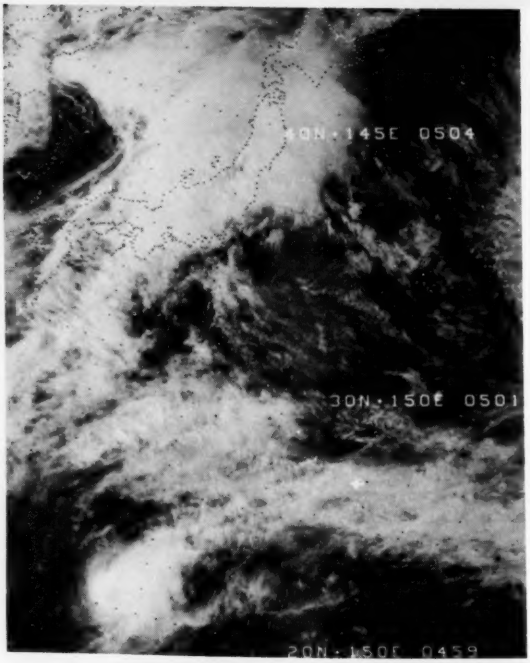


Figure 92.--By this time on the 24th a LOW has formed south of Osaka in the inverted trough. Typhoon Bess has crossed 20°N near 140°E.

This LOW came across the Yellow Sea and was already a 978-mb storm as it moved through the Tsugari Strait on the 30th. By the 31st the area bounded by 30° and 40°N and 140° and 155°E was loaded with strong gale-wind reports. A ship with call letters D5NL reported 25-ft seas. The PRESIDENT KENNEDY (45°N, 155°E) northeast of the 966-mb storm had 40-kn winds. Within the next 12 hr the speeds had exceeded 50 kn with the MOSEL EXPRESS finding 33-ft swells. It appears that the SEA-LAND EXCHANGE sailed almost directly through the storm's center at 1100 on the 31st with a pressure of 958 mb. The winds switched from east to north to west over a 4-hr period with highest speed 50 kn and waves 20 ft (fig. 93). The hourly winds and pressures were recorded on the back of the barogram from 2200 3/30 to 0700 4/01. They were strongest in the southwest quadrant from 2100 3/31 to 0500 4/01. On April Fools Day the WELSH CITY (35°N, 152°E) was finding 55-kn winds and 36-ft waves. The MIDAS RHEIN sailing south of the center and toward it had 64-kn winds. Waves reports over 25 ft extended from 145° to 175°E south of the center. She continued to have 60-kn winds and 25-ft seas into the 2d.

As the storm moved into the central ocean, its influence stretched from 30° to 65°N and 145°E to 150°W. The higher winds were about 45 kn and the waves 30 ft between latitudes 35°N and 40°N. On the 3d the storm was over the cold Bering Sea and retreating. The gradient had relaxed and it was no longer significant to large ships.

Tropical Cyclones--Typhoon Bess came to life on the 20th about midway between Yap and Guam. Beginning as a depression, she reached tropical-storm strength the following day. Bess was heading toward the northwest. By the 22d she was at typhoon strength. Peak winds climbed to 80 kn on the 23d as the typhoon continued to recurve and headed northeastward. By the 25th Bess was a tropical storm chugging south of Iwo Jima as she finished her tour of famous World War II islands.

Casualties--This was a bad month for Greek vessels on the North Pacific. The 14,202-ton Greek bulkcarrier MAIROULA reported Taiwan on the 8th with heavy-weather damage. The 12,498-ton AEGIS MAJESTIC sustained heavy-weather damage to deck pontoons. The 13,313-ton Greek bulkcarrier SEMI requested survey for heavy-weather damage on arrival at Innoshima on the 17th. The Greek bulkcarrier SAPHO (17,876 tons) sustained heavy-weather damage on the 29th while 300 mi north of Honolulu. Vessel diverted to Honolulu for repairs.

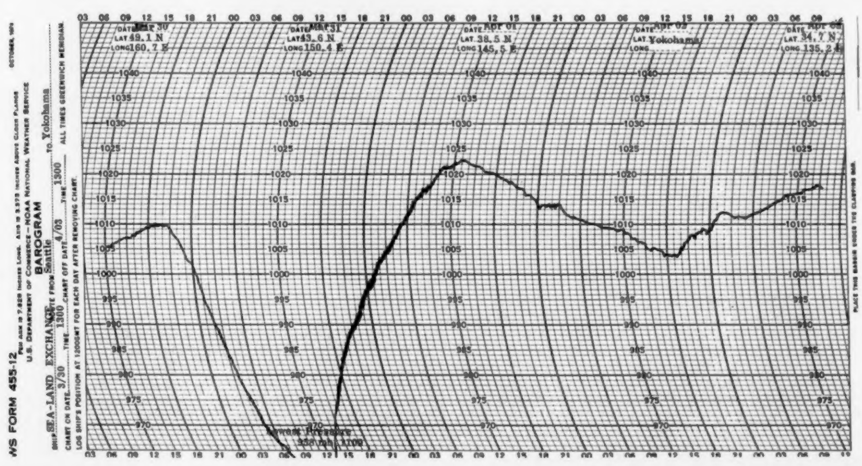


Figure 93.--The barograph pen went off the chart when the SEA-LAND EXCHANGE measured 958 mb at 1100 as she passed through or very near the center of the storm.

Marine Weather Diary

NORTH ATLANTIC, JUNE

WEATHER over the North Atlantic is usually very pleasant in June. The number of active extratropical LOWs continues to decline, and storms are usually confined to the higher latitudes--centers north of 45°N over the western ocean and 55°N over the eastern ocean. The building Azores High averages near 1024 mb for the month and is centered over midocean near 33°N, 38°W. The Icelandic Low, oriented east-west, is quite diffuse with the lowest average pressure about 1010 mb, just off the coast of Labrador, near 58°N.

WINDS are controlled largely by the Azores High, with the transient LOWs causing the daily variations. Between 25° and 55°N, southwesterly winds predominate, except over the eastern ocean from the Bay of Biscay southeastward, where northerly winds prevail. South of 25° to about 5°N, the "northeast trades" are generally steady. North of 55°N, winds are mostly variable. On the Mediterranean, east to southeast winds are common over the western half, while northwest winds blow steadily over the eastern portion. Northerly winds are predominant off the Iberian Peninsula and northwest coast of Africa. Northwesterly winds prevail over the eastern Gulf of Mexico, while southeasterly winds are predominant over the southern North Atlantic between the Equator and 5°N. Windspeeds over most of the North Atlantic during June are force 3 to 4. Lighter force 2 to 3 winds are most common over the Mediterranean Sea, Davis Strait, Gulf of Mexico, Bay of Biscay and waters southwestward, and near the Equator. A band of force 4 to 6 extends northeastward from the vicinity of Bermuda toward Ireland.

GALES over the North Atlantic are infrequent during June. Only in the waters near southern Greenland and over northern portions of the Norwegian Sea does the probability of encountering gales exceed 10 percent.

EXTRATROPICAL CYCLONES are fewer in June than in May and not as intense. Cyclogenesis throughout the summer occurs principally in the area from the Carolinas, west of 65°W, to Hamilton Inlet, Labrador, west of 50°W; north of Scotland; northwest of Iceland; over the waters southwest of the British Isles; and over the Gulfs of Finland, Riga, and Bothnia. The major storm tracks during June extend from the Newfoundland area northeastward to the waters south of Iceland, and then east-northeastward across the Scandinavian Peninsula. Another primary track extends from Iowa across central Lake Michigan to southern Lake Huron and down the St. Lawrence River, where it joins a track that develops off Cape Cod.

TROPICAL CYCLONES. Tropical storms average about one every 2 yr. The preferred area of tropical cyclone formation is over the western Caribbean and the Gulf of Mexico. The 47-yr period, 1931-77, had 25 tropical storms, of which 11 reached hurricane strength.

SEA HEIGHTS of 12 ft or more occur between 5 and 10 percent of the time over a broad area that includes the Labrador Sea, around the southern Greenland coast into Denmark Strait, then south of Iceland to the Faeroe Islands and southward to off Ireland's west coast, then southwestward to about 500 mi off Cape Race, and northwestward to include again the Labrador Sea. Other small areas are located between Norway and the Shetland Islands, off the central Norwegian coast, and in the Gulf of Lions. Frequencies of 10 percent or more occur only over an elliptical area immediately south of Kap Farvel. A flat oval area of swell greater than 12 ft over 10 percent of the time is centered about 55°N, from south of Kap Farvel to Ireland. The oval changes from about 5° to 10° of latitude thick from west to east. An area of over 20 percent occurs about 200 mi off the coast of Colombia.

VISIBILITY. The frequency of fog approaches its maximum over the northern ocean. The Grand Banks is the foggiest region--visibility below 2 mi is reported on more than 30 percent of all observations. The percentage of this low visibility decreases to between 20 and 30 percent of the observations over the Davis Strait and the northern Labrador Sea, and over the waters east of Kap Brewster, Greenland. The latter area is usually ice-covered at this time of year. The fog is generally observed in warm, moist air brought by southerly winds into this area of cold ocean temperatures.

NORTH PACIFIC, JUNE

WEATHER. The summer regime is well established over the North Pacific in June. Vigorous extratropical storms are increasingly less frequent. The Subtropical High is centered near 36°N, 149°W, and has an average central pressure of about 1022 mb. The Aleutian Low, located north of the western Aleutian Islands, fills rapidly during June; by the end of the month, it has disappeared, leaving only a trough.

WINDS north of the trade wind belt are variable over the broad scale, ranging from northwesterly to northerly off the United States and Canadian coasts, to southerly east of Japan, to westerly over the Aleutians. Over the Gulf of Alaska, they are southerly to westerly. Northeast of Hawaii, the winds blow from the northeast. The speeds average force 3 to 4 north of 25°N. South of 25°N (30° east of 145°W) to the Equator, steady "northeast trades" dominate, with force 4 the most common speed. The southwest monsoon is established over the South China Sea. Southeasterlies prevail over the Philippine Sea, switching to southerly south of Japan and Korea.

GALES are rare in June. Only over a small area near 46°N, 145°W, does the chance of encountering gales exceed 5 percent.

EXTRATROPICAL CYCLONES. The most favorable area for cyclogenesis continues to be east of Honshu.

The primary storm tracks lead from here east-northeastward to the Gulf of Alaska. Another track approaches the Gulf of Alaska on a northeasterly course from midocean.

TROPICAL CYCLONES. The probability of tropical storm development continues to rise sharply in June, approaching the late summer and early fall maximum. On the average, three of these storms develop per year--one or two during this month in Asiatic waters, and one or two over the ocean area between 10° and 20°N, and the Mexican west coast and 120°W. About two out of three western North Pacific tropical storms go on to become typhoons. One out of three eastern North Pacific storms reach hurricane intensity.

SEA HEIGHTS of 12 ft or more have a frequency greater than 10 percent only in two small areas. One is centered south of the Alaska Peninsula near 48°N, and the other south of the western Aleutians near 46°N. Generally, sea conditions are improving as summer approaches. Areas of high swell are located in the northern Gulf of Alaska and Bering Sea, south of the ice edge.

VISIBILITY. The frequency of low visibility increases over most of the North Pacific. The waters east of the northern Kuril Islands are particularly foggy, with the visibility dropping below 2 mi in over 40 percent of the observations. From the outer boundaries of this area northward to Kamchatka, southward to the central Kurils, westward to the eastern Sea of Okhotsk, and eastward to 162°E, this percentage drops to 30 to 40 percent of all observations. The area of low visibility, which encompasses 20 to 30 percent of all observations, extends from the southern Sea of Okhotsk through the central Kurils, and then eastward through the North Pacific along the 40th parallel to 165°W. The line bordering the boundary of the area then bends westward to midocean near 47°N, 175°E, before curving northeastward through the central Aleutians to St. Lawrence Island in the Bering Sea.

NORTH ATLANTIC, JULY

WEATHER conditions are relatively settled during July as the Azores High, centered near 35°N, 44°W, builds to a seasonal maximum of about 1025 mb, and primary storm tracks are displaced north of 45°N. The Icelandic Low remains an ill-defined east-west trough with the lowest pressure, about 1009 mb, centered near Hudson Strait in eastern Canada.

WINDS over the middle and northern latitudes have southerly and westerly components. Northerly winds are common near the entrance to the Mediterranean, while over the Sea itself, northwesterly winds are steady. Winds from the northerly quarter are found over the North Sea, off the central Norwegian coast, and over the Davis Strait and the waters southwest of Iceland. The "northeast trades" blow between 10° and 25°N, while in the Gulf of Mexico, easterly winds are most frequent. Near the Equator, southeasterlies dominate the area between South America and Africa. Windspeeds average about force 3 to 4 over most of these areas except over the Mediterranean Sea, the Davis Strait, and the Gulf of Mexico, where force 2 to 3 winds are prevalent. The strongest winds, of which nearly two-fifths of all observations are force 5, are encountered over the waters of the southwestern Caribbean Sea.

GALES. The frequency of gales is at a minimum for the year. Only over the Norwegian Sea is the percentage frequency of gales 10 percent or higher.

EXTRATROPICAL CYCLONES. From June to July, a marked northward shift of cyclonic activity occurs over the North Atlantic. Areas of cyclogenesis are along the North American coast from the Carolinas to north of Newfoundland, in the Denmark Strait, southwest and north of the British Isles, in the Adriatic Sea, and over the Gulfs of Bothnia, Finland, and Riga. The primary cyclone tracks lead from the Hudson Bay region northeastward through the Davis Strait, from the Grand Banks and the Gulf of St. Lawrence toward Iceland, and from north of Scotland eastward across southern Scandinavia. Two secondary tracks cross the Great Lakes. One extends from the Great Plains across eastern Lake Superior toward Labrador, while the other cuts an east-northeasterly swath across Lakes Erie and Ontario, New York, and New England, before merging with the Carolina storm track over the Gulf of St. Lawrence.

TROPICAL CYCLONE activity is still limited. On an average, three storms will occur during a 4-yr period, and half will develop into hurricanes. July tropical cyclones usually originate over the Gulf of Mexico or just east of the Lesser Antilles. Those forming over the Gulf generally move northward across the Gulf Coast, while those born east of the Lesser Antilles may move westward across the Caribbean Sea, or northwestward toward the southeast coast of the United States, where they often recurve to the northeast. Sometimes these storms are bred north and east of the Bahama Islands during July.

SEA HEIGHTS of 12 ft or more are encountered with a frequency of 10 percent or more only in a small area immediately south of southern Greenland.

VISIBILITY. Like June, July is one of the foggiest months of the year over the western North Atlantic. Observations with visibility less than 2 mi average 10 percent or more northward of a line drawn from the waters between Cape Cod and Cape Sable northeastward to near 60°N, 30°W. From there, the 10-percent frequency line runs eastward, south of Iceland, to near the Faeroe Islands, and then southward, cutting across Scotland near the Firth of Forth. The line then extends northward along the Prime Meridian to about 63°N, where it heads northeastward to the coast of Norway. The 20-percent frequency line is a little less erratic. It extends from near Cod Island, Labrador, eastward to near 56°N, 47°W; it then extends southwestward across Newfoundland to the Grand Banks. From there, visibilities less than 2 mi occur 20 percent or more of the time west of a line drawn to the coastal waters of Greenland, near Kap Mosting, and then north of the same line extended to 74°N, 20°E. Enclosed within the area defined by Godthaab (Green-

land), Resolution Island, and Ivigtut (Greenland), observations with visibility less than 2 mi exceed 30 percent.

NORTH PACIFIC, JULY

WEATHER. The steady and rather settled summer weather conditions that commenced in June over the North Pacific become widespread and firmly established during July. The Aleutian Low has disappeared from the pressure chart of normals, and the Subtropical High, with a pressure of 1026 mb, has moved northward to near 38°N, 150°W.

WINDS. Because of the strong development and northward position of the Subtropical High, the "northeast trades" extend over a large portion of the ocean. They prevail over all but Asiatic waters south of 30°N. Over the eastern ocean, they extend northward to about 35°N. The southwest monsoon is well established in Asiatic waters, blowing most steadily over the South China Sea. The westerlies of the middle latitudes, because of the absence of the Aleutian Low, are less steady than during the colder months. Large southerly components are found over the western two-thirds of the ocean at these latitudes, while northerly components are the rule closer to the conterminous United States and are also observed out from the Gulf of Tehuantepec. Easterly winds prevail over the waters of the Gulf of Alaska. Windspeeds over the Pacific average slightly less than force 4.

GALES associated with extratropical cyclones are rare during July over almost all of the North Pacific, but a frequency greater than 5 percent does exist over a 2° square north of the central Aleutians.

EXTRATROPICAL CYCLONES. Cyclogenesis during the summer occurs in Asiatic waters from Taiwan northward to Sakhalin, and northeastward to the Near Islands. The greatest frequency is east of Honshu and Hokkaido. Two other areas are found near 47°N, from 155° to 175°W, and over the Gulf of Alaska. The primary storm tracks lead from Honshu northeastward to the Bering Sea, and from a point near 52°N, 157°W, to the Gulf of Alaska.

TROPICAL CYCLONES. Usually three or four tropical storms occur over the western North Pacific during July. Only one of these will not become a typhoon. These storms originate mostly over the ocean areas east of the Philippines. During their early stages, they generally move west-northwestward; after development, some may continue across the northern Philippine Islands into the South China Sea, while others curve northwestward toward Taiwan, the coast of mainland China, Korea, or Japan. Those reaching higher latitudes generally recurve toward the northeast under the influence of the upper westerlies.

Another area of tropical cyclone activity is over the waters off the west coast of Mexico. Around four tropical storms can be expected in July, with one reaching hurricane force. These storms are usually shorter lived, but can be dangerous to both marine and coastal interests. They normally move west-northwestward out to sea, but sometimes they pass inland over Baja California.

SEA HEIGHTS of 12 ft or more may be expected about 10 percent of the time in two small areas south of the Aleutians, near 48°N, 165°E, and near 49°N, 155°W. Areas of high swells are located in the Gulf of Alaska and Sea of Okhotsk.

VISIBILITY. Compared to other months of the year, the occurrence of low visibility over northern waters is most frequent during July. The visibility drops below 2 mi in over 40 percent of all observations over a circular area bordering the northern Kurils on the west and centered near 48°N, 158°E. The 30-percent frequency line is less circular, running from southwestern Kamchatka across the central Kurils to a point near 43°N, 160°E, and then northeastward to the Rat Islands, before swinging westward to Mys Shipunskiy. The 20-percent frequency line also crosses the central Kurils, but extends farther up the west coast of Kamchatka. This line then continues southeastward from the Kurils reaching south of 40°N, between 160°E and the dateline, before moving east-northeastward to a point near 48°N, 145°W, and then north-northwestward to Afognak Island. The entire Bering Sea is enclosed within this 20-percent frequency line, with the exception of the waters northeast of St. Lawrence Island, and the waters north of a line drawn from Mys Ozernoy to Mys Navarin. The 10-percent frequency line is very similar to the 20-percent one. It stretches from the northern Sea of Okhotsk southward to the southern Kurils; it then continues southeastward to a point near 34°N, 170°E, before shooting east-northeastward to about 40°N, 140°W, and then north-northwestward to the Gulf of Alaska.

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THE 5-YR LIST OF NAMES FOR NORTH ATLANTIC TROPICAL STORMS AND HURRICANES

1979	1980	1981	1982	1983
Ana	Allen	Arlene	Alberto	Alicia
Bob	Bonnie	Bret	Beryl	Barry
Claudette	Charley	Cindy	Chris	Chantal
David	Danielle	Dennis	Debby	Dean
Elena	Earl	Emily	Ernesto	Erin
Frederic	Frances	Floyd	Florence	Felix
Gloria	Georges	Gert	Gilbert	Gabrielle
Henri	Hermine	Harvey	Helene	Hugo
Isabel	Ivan	Irene	Isaac	Iris
Juan	Jeanne	Jose	Joan	Jerry
Kate	Karl	Katrina	Keith	Karen
Larry	Lisa	Lenny	Leslie	Luis
Mindy	Mitch	Maria	Michael	Marilyn
Nicolas	Nicole	Nate	Nadine	Noel
Odette	Otto	Ophelia	Oscar	Opal
Peter	Paula	Philippe	Patty	Pablo
Rose	Richard	Rita	Rafael	Roxanne
Sam	Shary	Stan	Sandy	Sebastien
Teresa	Tomas	Tammy	Tony	Tanya
Victor	Virginie	Vince	Valarie	Van
Wanda	Walter	Wilma	William	Wendy

THE 4-YR LIST OF NAMES FOR EASTERN NORTH PACIFIC TROPICAL STORMS AND HURRICANES

1979	1980	1981	1982
Andres	Agatha	Adrian	Aletta
Blanca	Blas	Beatriz	Bud
Carlos	Celia	Calvin	Carlotta
Dolores	Darby	Dora	Daniel
Enrique	Estelle	Eugene	Emilia
Fefa	Frank	Fernanda	Fabio
Guillermo	Georgette	Greg	Gilma
Hilda	Howard	Hilary	Hector
Ignacio	Isis	Irwin	Iva
Jimena	Javier	Jova	John
Kevin	Kay	Knut	Kristy
Linda	Lester	Lidia	Lane
Marty	Madeline	Max	Miriam
Nora	Newton	Norma	Norman
Olaf	Orlene	Otis	Olivia
Pauline	Paine	Pilar	Paul
Rick	Roslyn	Ramon	Rosa
Sandra	Seymour	Selma	Sergio
Terry	Tina	Todd	Tara
Vivian	Virgil	Veronica	Vicente
Waldo	Winifred	Wiley	Willa

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